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Amina Abubakar

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Universiteit van Tilburg,
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van een door het college voor promoties aangewezen commissie
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door

Amina Abubakar

geboren op 23 september 1974 te Bungoma, Kenia

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I dedicate this book to my late parents, Naima Swaleh and Abubakar Ally.

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CHAPTER ONE

General Introduction

Conditions of infants and toddlers in Sub-Saharan Africa

*Sub-Saharan Africa (*SSA) is home to more than 112 million of the world's children (UNICEF, 2005). A significant proportion of these children face medical and environmental risks, such as malaria or HIV infection or poverty and under nutrition, acknowledged in other settings as contributing to impaired physical, motor, cognitive, social and emotional development. Yet few studies have been carried out to document the effects of exposure to adverse conditions on developmental outcome in this region. Differences in the constellation of risk factors and different support system may modify the patterns of outcome and magnitude of developmental problems in Africa. Resources for intervention are limited for infants growing up in SSA. The disease burden in this region is approximated at 21.4% of the global burden of disease with a meager global health budget of 0.7% (Murray & Lopez, 1997). The lack of adequate and proper health care may lead to the exacerbation of disease effects in Africa.

The current project intends to contribute to knowledge by describing developmental outcome of a cohort of children from a resource-limited setting in SSA. The remainder of this chapter presents a review of the relevant literature, theoretical background and methodological issues related to the project.

The early years: conceptual issues

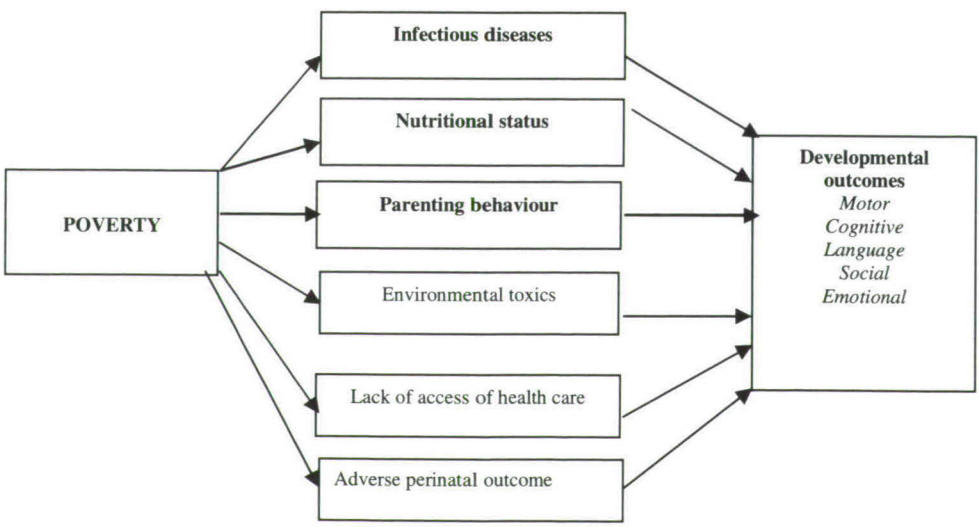
The brain, the organ that controls some of the most basic functions such as movements and reflexes, as well as more complex functions such as storing and processing of information from the environment is the most undifferentiated organ at birth (Zigler, Finn-Stevenson, & Hall, 2002). During the early years of life the brain develops rapidly through a set of interrelated processes such as neurogenesis, myelination, synaptogenesis, and synaptic pruning (Grantham-McGregor et al., 2007). By the age of three, the human brain achieves 75% of its potential and is as complex as it will be in adulthood. This process of development and differentiation is influenced by genetic, neurobiological as well as environmental factors (Shonkoff & Philips, 2000). Brain development and behavioural outcome later in life build on the early developed brain structures. Consequently, infancy and toddlerhood present a particularly vulnerable time for cognitive and developmental impairments resulting from early pre- and postnatal insults.

Childhood poverty has been identified as one of the biggest threats to development. Poverty whether measured in terms of income, parental education,

or other indicators, has been associated with low IQ scores, emotional and behavioural problems, underperformance on cognitive tasks, and poor verbal skills (Brooks-Gunn & Duncan, 1997; Duncan, Brook-Gunn, & Klebanov, 1994; Hoff, Laursen, & Twila, 2002). Effects of poverty are most detrimental when it is chronic and occurs early in the life of a child (Brooks-Gunn & Duncan, 1997). Regrettably, in the absence of early intervention the effects of poverty are not transitional. Low socioeconomic status (SES) in early years is predictive of future outcome such as IQ, achievement test scores, grade retention, functional literacy, and school completion among others (Duncan, Brooks-Gunn, Yeung, & Smith 1998; National Institute of Child Health and Human Development Early Child Care Research Network, 2005; Noble, Norman, & Farah, 2005).

Adverse conditions and other risk factors tend to cluster in children who are experiencing poverty (Olness, 2003). For instance, mothers from low SES status are more likely to have babies who are premature, low-birth weight, growth retarded and experiencing inadequate neurobehavioral development (Bradley, Corwyn, & Whiteside-Mansell, 1996). Postnatally, poverty is associated with, among other things, inconsistent parenting (Richter, 1994; Richter & Griesel, 1994; Richter & Grieve, 1991), limited nutritional intake, inadequate health care, inadequate cognitive stimulating materials and resources, poor housing (Bradley & Corwyn, 2002), family turmoil, chaotic households, and crowded homes (Evans 2004). Therefore there are potentially many pathways by which poverty affects child development. Figure 1 presents a summary of some of the most salient of these factors as they apply in developing countries. These factors have been identified based on several reviews (Olness, 2003; Walker et al., 2007). The current project defines the relative contribution of the pathways related to infectious diseases, nutritional status and parenting behaviour (printed in bold).

Figure 1. *Pathways by which poverty may impact on child development*

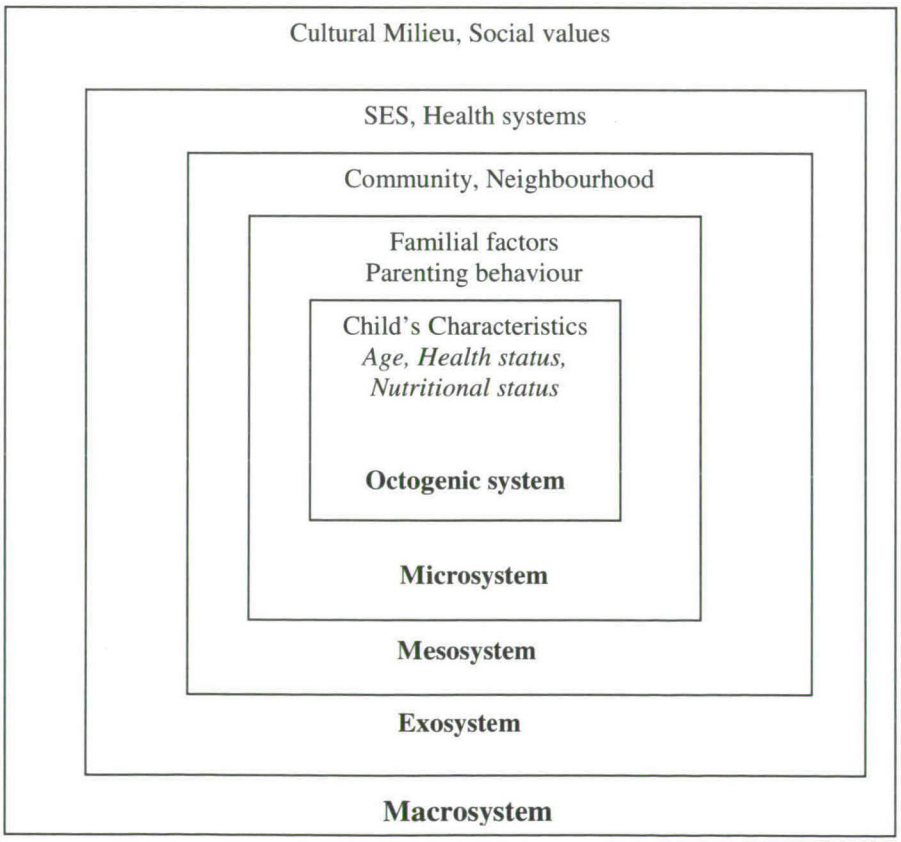


Infectious diseases are among the most common biological risk factors threatening infants in developing countries. They are the leading causes of mortality, disability and impairment worldwide (WHO report, 1999). Most of these effects result from only six infectious diseases; malaria, HIV, diarrhoeral disease, acute respiratory infections, tuberculosis and measles. The two infectious diseases of interest to this project have been associated with multiple developmental delays. Long term sequelea of malaria, especially its severe form cerebral malaria, include neurological problems, motor impairment, speech and language impairment, learning and behavioural problems (Boivin, 2002; Carter et al., 2006; Carter et al., 2005; Holding & Snow, 2001; Holding, Stevenson, Peshu, & Marsh, 1999; Idro, Carter, Fegan, Neville, & Newton, 2005; Newton, 2005; van Hensbroek, Palmer, Jaffar, Schneider, & Kwiatkowski, 1997). Similarly HIV has been associated with motor impairment, language impairment, cognitive problems, and social-emotional problems (Brown, Lourie, & Pao, 2000; Foster et al., 2006; Mellins, Levenson, Zawadzki, Kairam, & Weston, 1994; Smith et al., 2006; Willen, 2006). Another common risk factor results from *nutritional deficiencies.* These deficiencies, measured in varied ways such as micronutrient deficiency, hematological problems and anthropometric status, have been associated with increased risk of mortality (Black, Morris, & Bryce, 2003), morbidity (Tonglet et al., 1999), and developmental delay and impairments (Bryan et al., 2004; Grantham-McGregor, 1984; Grantham-McGregor & Ani, 2001; Hughes & Bryan, 2003; Lucas, Morley, & Isaacs, 2001). *Quality of care giving* has been associated with mental, behavioural and physical development (Richter, 1999). Early brain development can be disrupted by inadequate, inconsistent and or dysfunctional care giving patterns which may result in poor behavioural, physical and cognitive outcome (Richter, 1999). Therefore the kind and extent of infectious diseases, nutritional deficiencies and care giving patterns may present potentially salient pathways between SES and outcome in a rural African setting.

The bio-ecological theory (Bronfenbrenner, 1979; Bronfenbrenner & Ceci, 1993), provides the main theoretical background for this work. According to this theory, human development is a result of an interaction between the person and the environment. Individuals develop in relationship with and as inseparable part of their social context. The ecological environment of the individual is envisioned as a set of nested structures; representing the microsystem, mesosystem, exosystem, and macrosystem (Figure 2). The *micro-system* is the most influential to the child since it consists of persons and institutions that directly interact with the child and stimulate or hinder developmental outcome. The persons and institutions in the micro-system interact with each other to influence child growth and development. These interactions compose the *mesosystem.* The third level is the *exosystem* which is made up of persons and institutions that do not directly interact with the child but whose activities indirectly impact on child's

development, like conditions at work for the parents. The world views, ideologies, and customs of specific cultural groups compose the *macrosystem*. This level affect child development through its influence on behaviour and activities of adults surrounding the child (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 1998). The ecological theory is especially difficult to study since there are multiple layers. However its ability to inform and guide intervention has made it the most efficient approach to studying children in disadvantaged environments (Trawick-Smith, 2003) hence its application in the current project. The current project focuses on the study of the microsystem, including important biological characteristics and conditions of the individual children, and on understanding how these aspects contribute to variability in outcome.

Figure 2. *The bio-ecological framework as applied to the current project*



Assessment issues

A major limitation for understanding the effects of exposure to adverse conditions in SSA is the absence of culturally appropriate, valid and reliable

measures of childhood outcome, standardized for this population (Holding et al., 2004). Three assessment approaches have been proposed to address this shortage in measures (Van de Vijver & Tanzer, 2004). These are adoption, adaptation, and assembly. Adoption involves the literal translation of an instrument into the target population, which provides a quick and tested approach for assessment. However measures adopted from other cultural settings may constrain within-population variance, fail to show expected improvement with age and even mask true group differences (Baddeley, Gardener, & Grantham-McGregor, 1995; Connolly & Grantham-McGregor, 1993; Oluyomi & Houser, 2002). The inadequacy of the adoption approach results from the fact that psychological measures reflect values, knowledge and communication strategies of their culture of origin (Ardila, 2005). Three main dimensions of culture have been identified as having implications on human behaviour including the behaviour of a child during the administration of a developmental or psychological test. These cultural dimensions are value, symbolic and language systems (Gopaul-McNicol & Armour-Thomas, 2002). The value system refers to beliefs that govern day-to-day life and provide structure to the direction and regulation of behaviour while symbols refer to linguistic, pictorial, numerical and gestural technology. The language system refers to ways in which culture systematically communicates ideas, feelings, and thoughts through the use of words, sounds, gestures, and signals with commonly understood meanings (Gopaul-McNicol & Armour-Thomas, 2002).

These cultural influences may lead to several forms of bias in cross-cultural assessments that do not carefully consider the impact of test transference into a new culture (Van de Vijver & Tanzer, 2004). Three forms of bias can be distinguished. The first one is *construct bias*, which occurs when an instrument only partially samples the domains that define a construct. For instance, as the development of the modern intelligence test was based purely on Western definitions of scholastic achievements, it has a strong emphasis on aspects such as reasoning, memory and acquired knowledge. However in non-Western countries such as those in SSA, there is clear evidence that the conceptualization of intelligence has a very strong social aspect to it (Mpofu, 2002). Therefore the use of Western measures may not fully capture the abilities of African children. Furthermore the Western instruments may not sample relevant skills for adapting to the African environment.

The second bias consists of *method bias* which refers to problems that arise due to instrument characteristics and methodological issues. Methodological issues arise from the procedures used to collect information. Included here are errors in results arising from comparing two samples that differ significantly. For instance, it has been observed that the performance of schooled and unschooled children on developmental, cognitive and psychological tests differ significantly. Therefore, using norms or differently comparing schooled and non-schooled

populations may to lead to assessment bias. Another source of bias would be stimulus familiarity. Being unfamiliar with a stimulus not only impacts on task performance (Sonke, Poortinga, & de Kuijer, 1999) but it can also disrupt an assessment session. In an assessment of Laotian children the assessment session was disrupted because the children were afraid to pick up a raisin due to its similarity to a local medicine they had been socialized to avoid (Miller, Onotera, & Deinard, 1984).

The assessment context is yet another source of bias. Most assessment measures have laid down procedures and conditions for administration. It is usually assumed that all children understand the norms within the assessment context and would respond accordingly (Gopaul-McNicol & Armour-Thomas, 2002). However, it has been observed that in several instances the test administration procedures may not be culturally appropriate (Foxcroft, 2002). For example most ability tests involve one to one interaction between the assessor and the child. However in some cultures, it is unfamiliar for children to spend time in prolonged dyadic play with an adult. Involving them in this strange/ unfamiliar process may impact on their performance. Familiarity with test requirements and needs is arguably the biggest challenge in cross-cultural assessment. Testwiseness represents the ability to work fast and accurately, which remains a major source of performance differences. In the West children are encouraged to acquire this ability early in life. Several researchers report that this concept may not be familiar to children from other cultures and may impact on their performance (Boivin, Giordani, & Bornefeld, 1995; Roselli & Ardila, 2003).

The last form of bias is *item bias*, this occurs when items have a differential level of meaning or difficulty in different communities. These differential levels of difficulty may arise from poor translations of items, which may lead to ambiguity or clue giving to a certain group (Van de Vijver & Tanzer, 2004).

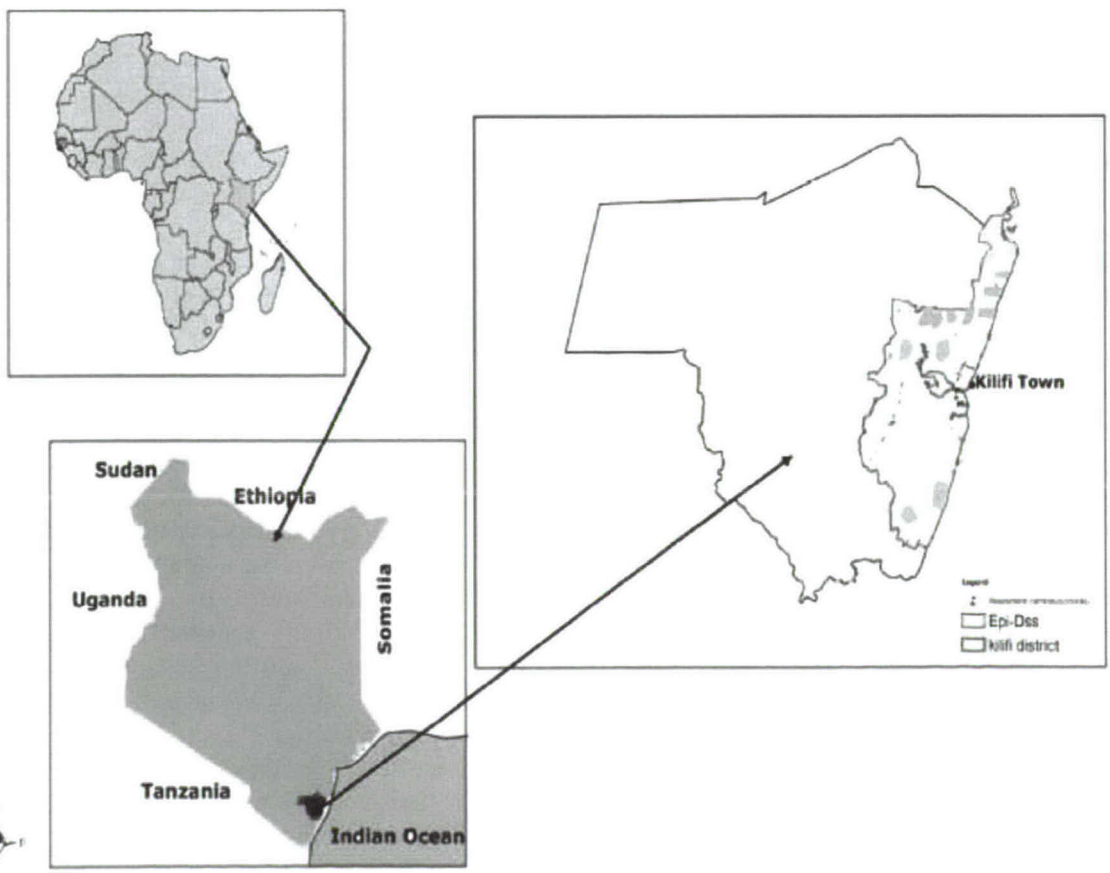
Adaptation and assembly provide the most adequate approach for dealing with shortage of assessment measures (Malda & Van de Vijver, 2005). Adaptation involves a systematic evaluation of all aspects of a measurement instrument and modifying it where needed, to make it more suitable to the context. Assembly involves the development of a new measurement instrument. These approaches are expensive and time consuming. However, the availability of an instrument, which has been developed and rigorously evaluated on site, significantly enhances the ability to describe effects of exposure to risk factors. In the current project these two approaches were applied in developing outcome measures. The choice on whether to adapt or to assemble will largely depend on the estimation of how well the test can be used in the new environment.

Contextual issues: Site

The project was carried out in Kilifi, Kenya. Kenya is situated in Eastern Africa, bordering the Indian Ocean. The map below indicates the position of Kilifi (Figure 3).

Economic condition: Kilifi is one of the six districts in Coast Province. The district's population was estimated to be 866,000 by the end of 2001, with an average density of 69 persons per square kilometre. In Kilifi, the majority of families depend upon subsistence farming. Kilifi District is the second poorest in Kenya in terms of income per capita with approximately two-thirds (66.8%) of the population living below the poverty line, indicating that they cannot afford basic food and non-food items (Ministry of Planning and Development, 2001).

Figure 3. *Map indicating the position of Kilifi within the African continent*



The shaded areas indicate areas from which the current project sampled children
Maps: Courtesy of the Kilifi DSS team.

Social environment: Many families are polygamous, and the care of children is shared within the homestead. The biological mother may not look after children who are no longer breast-fed. As the child is fully weaned around 2 years of age, increasing amounts of time are spent under the care of older siblings rather than adults. The intergenerational relationships in this community are strictly regulated by cultural habits (Wenger, 1989). Children above the age of two tend to play with their siblings and grandparents. The parents perform a disciplinary role; hence they do not pay attention to their children's play. Observations have shown that whilst there is a lack of shop-bought materials for playing children have access to homemade play items, often produced by older siblings (Taylor & Katana, 2004). Up until the introduction of free primary education in 2003, only 70% of children attended any school and about one-third failed to complete primary school. The majority of the population in the area belongs to the Mijikenda ethnic/linguistic group. Two Bantu languages are most commonly spoken in the area, namely Kigiriama (a member of the Mijikenda group of languages) and Kiswahili (which is widely spoken across Eastern Africa).

Health conditions and risk factors: Kilifi District is served by one tertiary level hospital the Kilifi District Hospital. The hospital serves over 230,000 people. As a tertiary hospital it serves as a first referral hospital and provides leadership, supervision and care in support of a network of peripheral primary care providers (English et al., 2004). The network in Kilifi consists of 5 government run clinics and 15 private clinics. These services are generally considered inadequate with only 30% of the population being able to access hospital services (Maitland et al., 2006). 70% of the children in Kilifi are born at home (English et al., 2003). Infant mortality is placed at 30 per 1000 while under-five mortality is 111 per a thousand: one of the highest rates in the country (English et al., 2003). Common causes of neonatal deaths in hospital include prematurity, severe infection and jaundice (English et al., 2003). Kilifi is a malaria endemic area, with two annual peaks of malaria corresponding to two rainy seasons (Idro et al., 2005). Every child in this district is exposed to malaria with each receiving between 10 to 100 mosquito bites infective of malaria annually. Approximately 9% of the mothers attending antenatal care at the Kilifi District Hospital test HIV positive. Malnutrition is endemic in Kilifi with over 40% of children having anthropometric features of under nutrition and about 47% presenting with biomedical markers of iron deficiency (Maitland et al., 2006). This is likely to be an underestimation since most of the estimates are based on hospital records, yet only 30% of the population does access these services; with the most rural and remote areas being under-served. A recent survey indicates that 61 per every 1000 children in Kilifi join school with a neuro-impairment (Mung'ala- Odera, 2006). These estimates are considered modest since the measure used is a screening tool that only detects gross impairments and therefore may underestimate the degree of the problem (Mung'ala-Odera et al., 2004). Postnatal insults, such as birth

trauma and neonatal sepsis in the first five years of life were identified as the main risk factor for neuro-impairments in Kilifi (Mung'ala-Odera et al., 2006). The results by Mung'ala-Odera et al are consistent with those from other parts of Africa (Wolf et al., 1997).

Population in the study

The population in this study consists of several sub-samples. The first empirical study reported here involved 180 children aged 11-109 months. The other studies reported in the thesis are based on a sample of 480 infants and toddlers aged 6-35 months. The infant-toddler sample has several sub-samples (319 children recruited from a rural community, 104 urban children, 48 children prenatally exposed to HIV and 9 children with neurodevelopmental disorders). These children were all recruited within resource-limited settings and many live in deprived environments. Table 1 summarises some SES information from 319 children from Kilifi, to illustrate the background characteristics of our target sample. As can be seen in Table 1, most children came from a home where parents had a low education level (only 15% of the fathers in Kilifi had secondary education or above), with very few holding professional jobs (6%). Most of the study population in the rural setting lived in houses made of mud and thatched with grass.

Table 1. *Socio-Economic Indicators in the Sample from Kilifi*

	Parental Characteristics	
	Father	Mothers
Educational Levels		
No schooling	11%	42%
Primary school incomplete	59%	40%
Primary school Complete	4%	14%
Secondary and Above	15%	4%
Missing Information	11%	0
Employment		
Unemployed	<1%	3%
Self-employed	15%	24%
Farming	17%	61%
Skilled labour	14%	2%
Unskilled labour	38%	2%
Professionals	6%	2%
Missing information/dead	9%	6%

Thesis outline

The project set out to achieve the following aims:

1. To develop psychological assessment measures of child outcome for use in resource-limited settings and to evaluate their psychometric properties.
2. To estimate the impact of infectious diseases, particularly HIV and poor nutritional status, as indicated by anthropometric measures, on developmental outcome.
3. To evaluate the role of parenting behaviour and conditions of stimulation at home in shaping the development of children who live in environments with limited resources.
4. To describe and evaluate the potential role of target communities as partners in improving both the quality of psychological research and services aimed at paediatric populations in Africa.

The results of this study are described in seven sections. The *first* section presents a general introduction of the theoretical, methodological and contextual issues relating to the project. The *second* section focuses on psychological assessments in SSA. This part consists of two chapters presenting two empirical studies that describe the design, evaluation and psychometric properties of the main measure used in this project, the Kilifi Developmental Inventory.

The *third* section describes and evaluates the role of anthropometric status in the variability in outcome among children from low SES. This part consists of two chapters. Chapter one will present a cross-sectional study while chapter two presents a longitudinal one. The *fourth* section focuses on the effect of HIV on the neurodevelopmental outcome of children in SSA. One chapter presents a review of studies from SSA on the effects of paediatric HIV on neurodevelopment, with an emphasis on the patterning and seriousness of impairment. The other chapter concerns an empirical study of outcome in 48 children prenatally exposed to HIV. The *fifth* section of the study focuses on parenting. This part consists of one empirical chapter that describes the development and evaluation of a measure of parenting behaviours and quality of the home environment. The *sixth* section of the study looks at the potential role of members of the community in enhancing psychological research and services for children. This part presents a review of methods used by psychologists across Africa to gather information from community members to improve the validity of their work, and an empirical study of the potential role of the mothers in the developmental monitoring of infants. The *seventh* section presents a summary of the results as well as discussion and conclusions arising from the studies described in this thesis. Theoretical and practical implications of these findings are discussed, cumulating in several recommendations.

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CHAPTER TWO

Developing Psychological Assessment Measures

CHAPTER 2.1
ASSESSING DEVELOPMENTAL OUTCOMES IN CHILDREN FROM KILIFI, KENYA FOLLOWING PROPHYLAXIS FOR SEIZURES IN CEREBRAL MALARIA*

Abstract

The purpose of the study was to develop a culture-informed measure of developmental outcome and to apply it to detect differences in developmental level between children with cerebral malaria enrolled in a clinical trial to control seizures during the acute phase of the illness. The instrument was administered to a sample of 180 children, 3 and 12 months after discharge from hospital. The measure demonstrated high internal consistency, good inter-observer reliability, age sensitivity, and strong relations with parental report of child functioning. No association was found between performance, or change in performance, with the prophylactic regime administered. The results suggested that the use of Phenobarbital in controlling provoked seizures has no observable effect on cognitive function.

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The adequate monitoring and evaluation of disease effects, related risk factors and intervention among children in rural communities in Africa is hampered by a lack of appropriate assessment instruments (Holding et al., 2004). Instruments developed in one culture cannot be readily transferred to another culture despite extensive evidence that the structure of cognitive abilities of children and adults is invariant across cultures (Georgas, Weiss, Van de Vijver, & Salkofske, 2003; Van de Vijver, 1997).

Among the most widely used of the published measures of developmental outcome in the early years are Bayley Scales of Infant Development (Bayley, 1993), Griffiths Mental Development Scales (Griffiths, 1954), and the Denver Developmental Screening Test II (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992). Examples of the application of these measures in Africa are described by Sigman, Neumann, Jansen, and Bwibo, (1989) in Kenya and Drotar et al. (1997) in Uganda. Both studies replaced pictures and objects of the Bayley Scale of Infant Development when original items unfamiliar to the children elicited no adequate responses. Similar modifications have been required when applying tests designed for older children. Boivin et al. (1995), working in the Democratic Republic of Congo, found that activities depicted in the Photo Series of the K-ABC were so unfamiliar that even school-going children could not complete the subtest. Holding et al. (2004) replaced the coloured plastic material used in the Triangles subtest of the K-ABC with wooden sticks in an adaptation of the test for 6-year olds in Kenya, when it was found that many children refused to touch the plastic material. Once modifications to test instructions, item content and procedures are made to maintain construct validity and sensitivity to within-population variations in ability, the original standardisation of the measure is then rendered invalid.

Other challenges to the application of western instruments in a non-western context arise from a lack of familiarity with test demands (e. g., responding to a strange adult in one-to-one interaction), incomparability of samples being compared (e. g., schooled vs. non-schooled), and poor translation of test items (Holding et al., 2004; Van de Vijver, 1997). Problems with applying and adapting standardised assessment techniques in Africa begin with the often prohibitively high price of western materials (Aina & Morakinyo, 2001) and are compounded by the shortage of trained and qualified test administrators (Haataja et al., 2002; Olness, 2003). The numerous challenges described highlight the need to develop culture-appropriate items, administration procedures and the establishment of culture-specific norms for the interpretation of score levels.

Malaria in Africa is estimated to account for "40% of public health expenditure, 30-50% of inpatient admissions, and up to 50% of outpatient visits in areas with high malaria transmission" (World Health Organisation, 2005). It is also the leading cause of mortality in under-fives, accounting for 20% of deaths (World Health Organisation, 2004). Cerebral malaria, the most severe form of

malarial disease, accounts for 10% of in-patient admissions in malaria-endemic regions. Over 80% of children with cerebral malaria have a history of seizures and 60% show seizures after the onset of treatment (Crawley et al., 1996; Lesi, Nwosu, Mafe, & Egri-Okwaji, 2005; Waruiru et al., 1996).

The occurrence of multiple and prolonged seizures in cerebral malaria has been associated with increased risk of mortality (Jaffar, Van Hensbroek, Palmer, Schneider, & Greenwood, 1997) and the presence of neurological sequelae (Bondi, 1992; Holding & Snow, 2001; Molyneux, Taylor, Wirima, & Borgstein, 1989) that persist several months post discharge (van Hensbroek, Palmer, Jaffar, Schneider, & Kwiatkowski, 1997). Hemiplegia, epilepsy, hemiparesis, ataxia, behavioural problems, visual impairment and delayed speech are commonly reported sequelae (Crawley et al., 2000; Idro, Jenkins, & Newton, 2005). While children can experience partial and even full recovery from some symptoms, including ataxia and cortical blindness, they never fully recover from others such as hemiparesis (Idro, Jenkins et al., 2005).

Studies involving both human and animal models have reported an increased risk of cognitive impairment following seizure activity. General cognitive impairment (Banu et al., 2003; Strafstrom, 2002), impaired spatial learning and memory (Majak & Pitknen, 2004), increased anxiety (Sayin, Sutula, & Strafstrom, 2004), motor impairment (Idro, Carter, Fegan, Neville, & Newton, 2005), school failure, behaviour and mental health problems (Freitag & Tuxhorn, 2005) have all been associated with multiple or prolonged seizures. The association between seizure activity and subsequent impairment in cognitive performance suggests the need for treatment and control of seizures during the illness episode. However anti-epileptic drugs may themselves contribute to the development of cognitive impairments (Kaindl et al., 2004). The exact nature and extent of the problems associated with the drugs may be related to type, dosage, and length of use (Aldenkamp & Bodde, 2005; Etchepareborda, 1999; Majak & Pitknen, 2004; Motamedi & Meador, 2003). Indeed, Aldenkamp and Bodde's (2005) review of the literature highlights the dilemma involved, noting the contradictory need to control seizure activity as early as possible while acknowledging the possible detrimental effects of prolonged use of the drugs on central nervous system function.

Like many countries in the region, Kenya lacks both appropriate tools to evaluate cognitive development and adequately trained personnel to administer them. The identification and diagnosis of children with special needs in Kenya is mainly carried out under the umbrella of the Educational and Assessment Resource Service, a unit of the Ministry of Education. The unit coordinates 52 district centres charged with the identification and support of the approximately 1 million children in the country with special needs (Muga, 2003). Children are identified through discussion with parents, that may be supplemented by the application of a screening test designed for children aged 6 months to 6 years

(Kenya Institute of Special Education, 1984). Each of five functional areas (motor, vision, hearing, speech and language, and emotional problems) is represented by a limited number of items restricting the application of this procedure to the identification of gross developmental impairments. In addition to this short instrument there is a need for an instrument that can provide more detailed information about a child's skill profile and detect more subtle impairments. The inclusion in such an instrument of developmental constructs commonly used in other settings would also allow for the comparison of outcomes across different study sites.

The aim of the present study was to develop a culture-informed measure of developmental outcome for use in resource-limited settings and to apply it to detect differences in developmental level between children with cerebral malaria enrolled in a clinical trial to control seizures during the acute phase of the illness. In this paper we describe the initial development of the Kilifi Developmental Checklist (KDC) and report on the reliability and validity of the tool.

Method

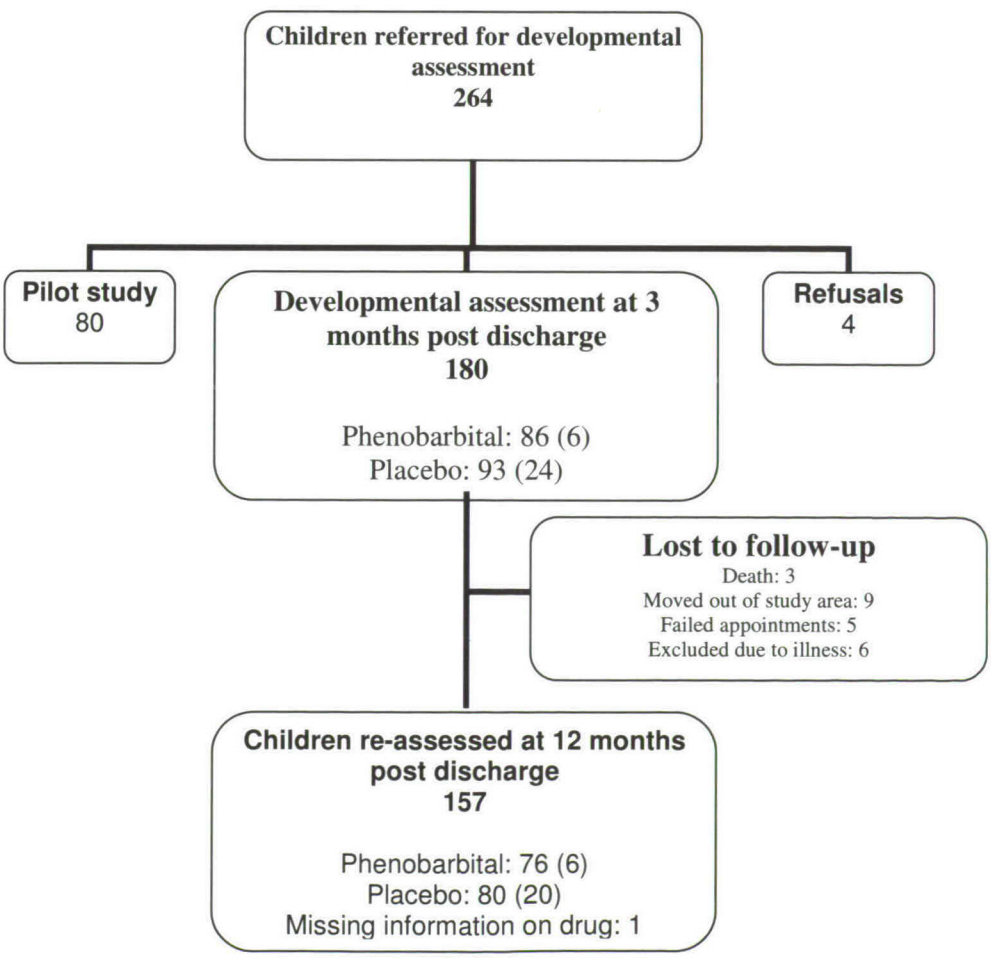
Study Site and Sample

The development of the assessment instrument took place at the Kenya Medical Research Institute, Kilifi, Kenya. Kilifi District is a predominantly rural community that stretches between Mombasa and Malindi along the Indian Ocean. The majority of the population in the area belongs to the Mijikenda ethnic/linguistic group. Two Bantu languages are most commonly spoken in the area, namely Kigiriama (a member of the Mijikenda group of languages) and Kiswahili (which is widely spoken across Eastern Africa). The majority of families depend upon subsistence farming. Low literacy levels and high poverty levels characterize the population. Sixty six percent of the population live below the poverty line (Government of Kenya, 2001). Extended families live in homesteads and share in child rearing. After weaning most children spend time with older siblings and spend little time in a dyadic interaction with an adult. Systematic observations have shown us that there are almost no shop-bought play materials and most children use homemade play items, often produced by older siblings (Taylor & Katana, 2004). Medical facilities in the district are centred upon one tertiary service, the Kilifi District Hospital, and five outlying government clinics. The district hospital also provides therapeutic services for children with disabilities in the form of a paediatric physiotherapy service and an occupational therapy department.

Eligible children were aged over nine months, and had previously been recruited for a study investigating the effectiveness of prophylactic dose of Phenobarbital as method of seizure control in the treatment of cerebral malaria (Crawley et al., 2000). A more detailed description of the sample can be found in

Crawley et al. (2000). All children had been discharged from Kilifi District Hospital between June 1995 and January 1998 following an episode of cerebral malaria, defined as unarousable coma (inability to localise a painful stimulus/Blantyre score of three or less), and the presence of P. *falciparum* parasites (Molyneux et al., 1989). Half of the children enrolled into the original study were randomly assigned to receive an intra-muscular dose of Phenobarbital, while the other half received a placebo. All children who subsequently had seizure activity were treated with Diazepam. Seizure activity was significantly lower in the acute phase of the illness in children in the Phenobarbital (or prophylaxis) arm of the study (11% vs. 27% of children experience 3 or more seizures). However the mortality in this group was doubled. Two hundred and sixty four children discharged alive returned for a 3-month neurodevelopmental assessment. Figure 1 illustrates the retention of subjects in this section of the study.

Figure 1. *Sample description*



Development of the Instrument

Phase one: Item selection. We employed an adaptation approach (Van de Vijver & Tanzer, 2004) to item selection, using constructs and items from previously developed instruments and modifying them in order to increase their appropriateness. Items in the pilot version of the instrument were drawn from several sources. Items from the Kenyan Screening Test for Children aged 6 months to 6 years (Kenya Institute of Special Education, 1984) were supplemented by items from the Griffiths Mental Development Scales (Griffiths, 1954), the Movement Assessment Battery for Children (Henderson & Sugden, 1992), Merrill Palmer Scales of Mental Tests (Stutsman, 1948), the Wessex Revised Portage Checklist (White & East, 1983), Wechsler's Preschool and Primary Scales of Intelligence (Weschsler, 1989), and tasks suggested by the Shoklo Neurodevelopmental Assessment (Haataja et al., 2002). An initial pool of 101 items was created on the basis of this review. Subsets of this pool were administered to children drawn from the local community. Special attention was paid to the development of appropriate instructions, different methods of observing and recording observations and to the suitability of the materials used. Excluded from the assessment of motor development was an item about climbing stairs, as stairs are not generally present in buildings in the area. Many of the gross motor activities were observed during the course of free play with a ball. Mothers and older siblings were encouraged to join in; the difficultly of simultaneously recording and observing the child was overcome by having a separate observer and facilitator.

Phase two: Tool development and evaluation. The first 80 children (39 female; mean age = 38.32 months; *SD* = 17.24; range 7-88 months) recruited were used to pilot an initial item list and to train a reliable assessment team. Items were selected for retention on the following criteria: (i) Clarity of observation: Success on the action/task can be readily determined by the observer; (ii) Within-population variance and age appropriateness: Range of performance observed in the target age range; (iii) Clarity of description: The behaviour can be easily described in the local languages.

Fifty-eight items were selected for inclusion in the final checklist. Items were grouped into four subscales (see Table 1): Locomotor; Eye-Hand Coordination; Hearing, Speech and Language; and Social-Emotional Development. The groupings were based upon the model provided by published developmental measures, particularly the Griffiths Mental Development Scale (Griffiths, 1954).

Table 1. *Description of Subscales of the Kilifi Developmental Checklist*

Name of subscale	Domain of assessment	Method of data collection	Items
Locomotor	The child's movement in space, static and dynamic balance, and motor coordination.	Interaction with the child	17
Eye-hand coordination	The child's ability to manipulate objects and to coordinate fine motor movements	Interaction with the child	17
Hearing, speech and language	Expressive language, comprehension and screens the child's hearing.	Interaction with the child	9
Social-Emotional	A child social functioning, adaptive behaviour and daily living skills.	Interaction with the child /Parental interview	15

The assessment of the first 80 children also provided the opportunity to train an assessment team and develop an administration manual outlining a standard format for test administration. The assessment team consisted initially of three community nurses, a fieldworker with extensive experience in administering parental interviews, and a local mother with limited formal education. The inclusion of personnel with a different range of experience was carried out to enable an evaluation of the minimum initial skill level required as a prerequisite for training. The training programme was run by one of the authors (Holding) and consisted of demonstrations, guided assessments, and videotaped assessment sessions. The videos were used to provide individual and group feedback and as a tool in the assessment of inter-observer reliability. Assessment skills were trained and evaluated through close observation, and through comparison of the scoring by each team member of the taped assessment sessions. In the training phase an inter-observer agreement of more than 80% was required for each item across the majority of team members. The skill level achieved by the nurses and the field worker were deemed sufficient to retain them in the project. The procedures administered by one member of the team, the mother, were found to be inconsistent. She was therefore dropped from the team.

Test evaluation: Materials and procedures. The final item list was administered to the remaining 180 children (88 girls) three months post discharge. The mean age of these children was 40 months (*SD* = 19.8, range: 11-109 months). Eighty six children (43 female) had received Phenobarbital. At 12 months post discharge, 157 (79 girls) of these children were assessed again. There was no significant difference in the attrition rate between boys and girls (14 and 9, respectively), nor between Phenobarbital and placebo children (13 and 10, respectively) (see Figure 1). All the tests were administered at the Kilifi District Hospital grounds in a room set aside for assessment. Each child was assessed in the presence of the mother/guardian. A team of two assessors administered the procedure. One of the team members took the role of observer and the other the

role of facilitator. The facilitator interacted with the child, introducing the items and giving the instructions to the child. The observer sat unobtrusively at the side of the room recording the child's responses and behaviour on the checklist. Tasks were scored on a three-point scale (0: child is unable to perform the task; 1: skills in the task are emerging; 2: child's skills in the task are established).

Parental reports were collected on a subset of 42 children. The parental report was elicited using a questionnaire developed in Kiswahili for use in Tanzania (Stoltzfus et al., 2001). The version of the questionnaire used contained 111 items, subdivided into three subscales; Motor, Social, and Emotional. Members of the assessment team translated the questionnaire into Kigiriama. In our population the full-scale questionnaire showed a value of Cronbach's alpha of .94. Moreover two subscales also showed high internal consistency (Motor: α = .84; Social: α = .93), while the value of the emotional scale was considerably lower (α = .58).

Data on a subset of 53 children were used to evaluate the test-retest reliability of the instrument. Five months were set aside to collect retest data, and children seen in that period were invited for a second visit, regardless of whether their original appointment was for the 3 or 12 months visit. The mean time between the two tasks was 22 days (*SD* = 5 days; range: 15-46 days).

Ethical considerations: Written informed consent was obtained from all families and guardians of study participants. For participants who were not literate the consent form was read out in the language with which they were most familiar. Assent was sought through discussion and play from all children prior to the developmental assessment. Approval for the study was obtained from the Kenya National Ethical Committee.

Data management and analysis: Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. Descriptive statistics were generated to evaluate the score distribution, including means, standard deviation and item difficulty. Scores were calculated for each of the 4 subscales, and a total score obtained for all 58 items combined. Principal component analysis of the subscales was carried out to examine the structure of the instrument. Estimates of internal consistency of the subscales were computed using Cronbach's alpha. Subsamples of children were selected at random to compute the inter-observer (n = 34) and retest (n = 53) reliabilities. Criteria set out by Cicchetti (1994; Cicchetti et al., 1992) were employed in evaluating the level of acceptability of the observed values of the reliability coefficient.

The subscale and total scores for each of the two time points, as well as the change in scores over the nine months between the two assessments (change score), were computed. Repeated Measures ANOVA was applied to evaluate the sensitivity of the tool to maturational changes. Correlations between the KDC and parental report were computed to evaluate criterion validity. Univariate and

multivariate association measures were computed to assess the effects of the prophylactic regime on developmental outcomes.

Results

Psychometric Properties

Descriptives and reliability: Descriptive and frequency tables were utilized to evaluate *item variance* in the population and to order items along a "developmental index". With the possible mean score per item in the range from 0 to 2, and observed scores ranging from 0.32 to 1.90, not less than 79% of the theoretical range was observed on all items. Results therefore indicate that all items showed sensitivity to within-population differences in ability. A developmental progression was also found. The proportion of children passing each item ranged from 2.8% ("Can wash themselves without supervision") to 98.3% ("Sits with support").

The evaluation of *internal consistency* was addressed in two ways. The first analysis employed raw scores, while the second analysis used scores corrected for age, to control for the possibility that the large age range included may inflate the internal consistency. Linear regression analysis was used to correct for the age differences; test scores were predicted on the basis of the child's age. The standardized residual scores of this analysis were then used to determine the internal consistency of the measure both at the full scale and subscale level. As can be seen in Table 2, all scores showed high internal consistencies; the alpha values for the raw scores ranging from .85 to .93, and for the age-corrected scores from .76 to .86. All these values are above the lower limit of .70 (Cicchetti, 1994), which points to a good internal consistency of all KDC scales. The combination of a good internal consistency and the large range of individual differences observed provide support for the adequacy of the instrument to assess individual differences in abilities.

Table 2. *Means, Standard Deviations and Cronbach's Alpha for the Scales and Each Subscale*

Domain	*N*	*M*	*SD*	α	α[a]
Developmental	178	80.50	26.26	.97	.94
Locomotor	180	19.31	8.68	.93	.81
Eye-hand coordination	180	20.20	8.42	.94	.86
Hearing speech and language	180	11.81	4.90	.89	.82
Social-Emotional	178	28.81	5.88	.85	.76

[a] internal consistency based on age-corrected scores.

Intra-class correlation coefficients (absolute agreement) were computed to estimate *inter-observer reliability* for the full scale and for each subscale. The values were excellent (Developmental: .88; Locomotor: .89; Eye-hand: .74; Hearing Speech and Language: .88; and Social-Emotional: .97).

Retest reliability was estimated by computing intra-class correlation coefficients (consistency) for the full scale and for each subscale. The values from the raw score were excellent (Developmental: .94; Locomotor: .91; Eye-hand: .93; Hearing Speech and Language: .83; and Social-Emotional: .88).

The *dimensionality* of the age-corrected subscale scores was studied in a principal component analysis. The four subscales yielded a strong first component, which accounted for 75% of the variance (eigenvalue = 3.02). Factor loadings were as follows: Locomotor .85, Eye-hand coordination .88, Hearing speech and language .86, and Social- Emotional .86. These results support the use of a summated score to compute an overall index called the Developmental Score. The internal consistency of the total instrument was very high (.97 for the raw scores and .94 for the age-corrected scores).

Correlations were computed to explore the relationship between *gender* and performance on the total score and for each of the subscales. Results indicate that there was no relationship between gender and the developmental score ($r(180) = .07$, $p < .30$), nor between gender and any subscale (Locomotor: $r(180) = .06$, $p < .37$; Eye-Hand: $r(180) = .05$, $p < .44$; Hearing, Speech, and Language: $r\ (180) = .08$, $p < .28$; Social-Emotional: $r(180) = .04$, $p < .55$). Consequently, gender was not considered in the remaining analysis. The absence of gender differences supports the validity of the instrument.

The age sensitivity of the KDC Total and Scale scores was investigated by examining their correlation with age. Very high correlations were found between age and the developmental score ($r(180) = .81$, $p< .001$) explaining approximately 67% of the variance, also between age and the subscales (Locomotor: $r(180) = .83$, $p < .001$; Eye-Hand: $r(180) = .72$, $p < .001$; Hearing, Speech, and Language: $r\ (180) = .73$, $p < .001$; Social-Emotional: $r(180) = .71$, $p < .001$), ranging from .71 to .83. Age explained on average 56% of the variance in the subscales scores. These correlations provide strong support for the age-sensitivity of the KDC.

Scores for children who were seen both at 3 and 12 months post discharge ($N = 157$) were used to evaluate the sensitivity of the KDC to *maturational changes*. The differences in scores between time 1 and time 2 are displayed in Table 3. A significant increase in scores over a nine-month period was observed for all scales (developmental score: $F(1, 155) = 81.71$, $p < .01$; Locomotor: $F(1, 156) = 135.05$, $p < .01$; Eye-Hand: $F(1, 156) = 45.28$, $p < .01$; Hearing, Speech and Language: $F(1, 156) = 35.61$, $p < .01$; Social-Emotional: $F(1, 155) = 19.23$, $p < .01$). Furthermore, there were positive and significant relationships between scores at these time points, indicating that rank order and relative distance between subjects were well maintained between the two assessments.

Table 3. *Test Scores at 3 and 12 Months after Discharge and Their Correlations*

	3 months			12 months			Correlations	
Domain	*N*	*M*	*SD*	*N*	*M*	*SD*	*r*	*pr*[a]
Developmental	156	81.4	25.6	157	92.3	26.4	.84	.69
Locomotor	157	19.7	8.1	157	24.8	9.8	.85	.61
Eye-hand coordination	157	20.2	4.7	157	23.2	7.1	.78	.63
Hearing speech and language	157	12.0	4.5	157	13.5	4.3	.74	.59
Social-Emotional	156	29.1	5.4	157	30.6	5.6	.68	.54

[a] partial correlation which corrects for the effects of age.

The *criterion validity* of the KDC was evaluated by comparing performance on the KDC with parental report. As can be seen in Table 4, there was a significant, positive relationship between most KDC subscale scores and parental report particularly for scales measuring similar constructs. The exception is the parental emotional scale, which did not have a significant relationship with two of the KDC subscales. These findings support the criterion validity of the KDC.

Table 4. *Correlations between KDC Subscales and Parental Report*

	Parental report			
Subscale	Motor	Social	Emotional	Developmental
Developmental	.55**	.76**	.31*	.73**
Locomotor	.59**	.75**	.31*	.72**
Eye-hand coordination	.45**	.60**	.26	.58**
Hearing speech and language	.41**	.69**	.20	.62**
Social-Emotional	.57**	.78**	.36**	.75**

$p < .05$. $^{**}p < .01$ (one-tailed).

Effects of Controlling Seizures on Cognitive Outcome

Scores for children at both 3 and 12 months post discharge were used to evaluate the prophylactic regime (Phenobarbital). The means and standard deviations at both time points are displayed in Table 5. Using age-corrected scores the differences between the groups were evaluated by means of an ANOVA. There were no significant differences at three months post discharge between the children who received the prophylaxis and those who received the placebo (Developmental score: $F(1, 176) = 0.33$, $p < .56$; Locomotor: $F(1, 178) = 0.49$, $p < .48$; Eye-Hand: $F(1, 178) = 0.98$, $p < .30$, Hearing, Speech and Language: $F(1, 178) = 0.12$, $p < .72$; Social-Emotional: $F(1, 177) = 0.11$, $p < .73$).

Table 5. *Means and Standard Deviations for Two Treatment Groups*

	3 months post discharge				12 months post discharge			
	Placebo group		Phenobarbital		Placebo group		Phenobarbital	
Scale	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Developmental	81.06	26.46	79.91	26.20	92.77	26.61	92.20	25.78
Locomotor	19.47	8.79	19.21	8.63	25.36	10.75	24.42	10.24
Eye-hand coordination	20.14	8.41	20.28	8.24	23.08	6.74	23.60	7.60
Hearing, speech and language	11.94	4.84	11.74	4.98	13.68	4.34	13.53	4.48
Social-Emotional	28.98	5.78	28.67	6.04	30.63	6.17	30.64	5.19

Similarly, no group differences were observed at 12 months post discharge (Developmental score: $F(1, 153) = 0.45$ $p < .50$; Locomotor: $F(1, 153) = 1.30$, $p < .25$; Eye-Hand: $F(1, 153) = 0.05$, $p < .80$; Hearing, Speech and Language: $F(1, 153) = 0.45$, $p < .50$; Social-Emotional: $F(1, 153) = 0.45$, $p < .50$). Furthermore, no significant group differences were observed at the scale and subscale level (see Table 6).

Table 6. *Means, Standard Deviations and Significance of the Difference Score*

Domain	Placebo group Mean (*SD*)	Phenobarbital Mean (*SD*)	*F*	*p*
Developmental	11.55 (17.38)	10.32 (11.29)	1.04	.30
Locomotor	5.53 (6.33)	4.69 (4.53)	1.23	.26
Eye-hand coordination	2.67 (5.51)	2.73 (4.66)	0.58	.44
Hearing, speech and language	1.66 (3.54)	1.42 (3.01)	0.56	.45
Social-Emotional	1.59 (5.10)	1.47 (3.63)	0.26	.60

Additional analyses (not further documented here) showed that there were no confounding effects of pre-admission seizure activities on performance 3 or 12 months post discharge. However, seizure activities after the administration of the study drug were associated with test performance. A group of children in each arm of the study trial (see figure1) experienced at least three or more seizures after the administration of the study drug. We analysed the outcome in this group of children at 12 months post discharge after adjusting for treatment group. The children who experienced multiple seizures performed significantly poorer than those who did not, $F(1, 154) = 8.21$, $p < .01$, $\eta^2 = .05$. Similar results were observed for each of the sub-scales (Locomotor: $F(1, 154) = 5.99$, $p < .02$, $\eta^2 = .03$; Eye-Hand: $F(1, 154) = 4.71$, $p < .03$, $\eta^2 = .03$; Hearing, speech and language: $F(1, 154) = 4.75$, $p < .03$, $\eta^2 = .03$; Social-emotional: $F(1, 154) = 11.55$, $p < .001$, $\eta^2 = .07$).

Given the sensitivity of the measure to maturational change an improvement in scores was expected over the 9-month follow-up period. However, as the amount of improvement may depend upon several factors such as the age of the child and the specific task, we chose to apply a conservative definition of impaired development, the decrease of test scores in at least two

subscales of the KDC. Of the 157 children investigated, 20 children met this criterion for developmental impairment. No significant association was found between seizure-related activities prior, during or subsequent to the malaria episode and this developmental impairment measure.

In addition, no association was found between a clinician's assessment of neurological impairment and the classification of developmental impairment. Only 2 of the 20 children so classified were also identified through the clinician's assessment at discharge as having neurological sequelae, and only one child so identified at the neurological examination at three months post discharge.

Discussion

Psychometric Properties

The Kilifi Developmental Checklist provides a standardised and reliable instrument for monitoring psychomotor development in a resource-limited setting. Within-population variance, internal consistency and retest reliability observed in this study supported both the suitability of the items selected and the reliability of the tool in our setting. Furthermore, the selection of culturally appropriate items ensured that the instrument was sensitive to normal maturational development, as shown in the significant improvement in performance of the study children over the 9-month follow up period. The reliability of the instrument was further supported by the consistency in the ranking of the performance level of the children over the same period.

These results provide justification for the time expended in developing this instrument in context. We did not find unexpected relationships between age and performance, as sometimes found for non-adapted instruments (Oluyomi & Houser, 2002). The increasing difference between the standardisation sample and diverse cultural groups that has been recorded as children get older may even suggest, inappropriately, a regression in skill development (Gay et al., 1995), compromising study results.

The shortage of personnel with a background in child assessment within the African context has been identified as a limitation to the feasibility of tests that require prior experience and extensive training (Olness, 2003). We have demonstrated that the KDC can be administered in a reliable and standardised manner by examiners with limited prior experience of child assessment. The high inter-rater reliabilities achieved attest to this. However, the inability of the mother with limited formal education to achieve the required level of competence demonstrates the potential need for a minimum level of secondary school education as a prerequisite for training.

In the absence of already existing tests there are different approaches that have been applied to the production of an assessment measure (Van de Vijver & Tanzer, 2004). Translation of already existing measures, while the most common approach, may constrict the within-population variance and mask true group

differences (Connolly & Grantham-McGregor, 1993). At the other extreme, the production of a novel assessment limits the comparability of outcomes across different cultural settings (Sternberg et al., 2001). The current study used an alternative approach that may overcome these limitations. We chose to assemble a selection of activities into a new measure, and care was taken to ensure that items included were not only acceptable to the target population but also evaluated constructs common to those measured by published tests. This is potentially important as it enables the comparison of disease effects across sites and contexts (Holding & Kitsao-Wekulo, 2004).

Factor-analytic evidence suggests that the KDC is unifactorial and primarily measures general developmental functioning. The combination of seemingly unrelated skills such as cognitive, locomotor, and social-emotional skills in a single factor is common to infant scales, and may be associated with the insufficient differentiation of skills in the early years to allow for the delineation of more discrete skills and functions that are observed later in life (Kline, 1993). The use of subscales does allow for the investigation of differential sensitivity of functions to early childhood disease (Boivin et al., 1995; Msellati et al., 1993). Indeed, studies carried out subsequently to the one reported here have found subscale differences in the evaluation of neonatal diseases (Barlow, Mungala-Odera, Gona, & Newton, 2001; Gordon, English, Tumaini, Karisa, & Newton, 2005), mitigating the need to differentiate component skills at certain levels of analysis.

A prerequisite for adequate criterion validation is the use of a gold standard as the criterion measure (Gregory, 1992). We did not have such a measure. Therefore, we investigated the extent to which the KDC, a primarily observational-performance measure, correlated with parental reports. The latter provided preliminary support for the criterion validity of the KDC.

The KDC uses a combination of performance-based assessment and parental report. The two assessment methods were combined to overcome the inherent limitations in each of the methods. This approach should enhance the reliability of the information collected and increase the likelihood that the performance level recorded is a true representation of the child's ability (Carter, Briggs-Gowan, & Davis, 2004). Our experience demonstrated that some behaviours can only be assessed through parental report, notably social functioning. Parents in this study, however, were not familiar with all the concepts presented to them, and were not able to report on the full range of their child's behaviours. Performance-based testing is required to elicit information of other functions of interest to the developmentalist. We conclude that future efforts should focus on specifying the distinction between the functional areas and evaluating the most suitable assessment approach for each of the areas.

The need to expand the assessment of children's development post discharge to enable the identification of children with more subtle sequelae is

highlighted by the lack of overlap between the neurological and the developmental assessment procedures. Based on our definition of poor development (a loss of skills in at least two of the KDC subscales) 12.7% (N = 20) of the children assessed at the second time point would need further monitoring. Ninety percent of the children identified as requiring monitoring and possible educational support would not have been identified by a clinical assessment of neurological functioning alone. Our findings highlight the need to develop and validate measures that can be used to supplement clinical judgement.

Control of Seizures in Cerebral Malaria

The purpose of the development of the tool was to investigate the possible subtle benefits of prophylaxis for seizures in cerebral malaria. Our results suggest that there were no long-term cognitive benefits to receiving a prophylactic dose of Phenobarbital. On the other hand, there was no indication that the children who received the prophylactic dose of Phenobarbital suffered any negative cognitive effects.

The lack of benefit can be explained by a number of factors. First, children in the Phenobarbital group experienced higher rates of death. This high attrition may mask the benefits of the prophylaxis, limiting the kind of conclusion that can be drawn. Secondly, children who experience cerebral malaria are a heterogeneous group. Clinical records show variability in signs and symptoms, and children experience a number of complicating factors that may impair brain function, such as hypoglycaemia. These factors could affect developmental outcome regardless of seizure activity, potentially masking the benefits of seizure control. A third limitation is the lack of a true placebo group. All children who developed seizure activity were treated with diazepam. A greater number of children in the placebo group developed seizures and were therefore not treatment free. There is a potential, but untested, confounding effect of this treatment on later outcome.

Because we did not find any differences between treatment groups it could be argued that the KDC was not sensitive to true group differences. We do not favour this interpretation because our data are in line with both the findings of the original study (Crawley et al., 2000) and the literature on seizure prophylaxis. The results of the neurological assessment, reported in Crawley et al., 2000, showing no effect on the presence of neurological sequelae at discharge or three months post discharge, corroborate the results of the developmental assessment. The only significant effect of prophylaxis was on provoked seizure activity. These results are similar to those of a number of different studies reviewed by Beghi, (2003) who concludes that "Based on the results of randomised clinical trials and meta analysis the prophylactic use of (AEDs) is effective in reducing the risk of early post traumatic seizures, whereas late seizures, disability and or death seem unaffected by active treatment" (p. 25).

Given both the evidence provided by Beghi and the sensitivity of the KDC to the effects of other neonatal complications (Barlow et al., 2001; Gordon et al., 2005), we conclude that the lack of group differences is much more likely a reflection of group characteristics than a reflection of limitations of the tool. Results suggest seizure activity may not be the mediating pathway between cerebral malaria and impaired development. However, the children who went on to experience multiple provoked seizures during admission did perform poorly on the developmental assessment at 12 months compared to those who did not, regardless of the drug received. Future investigations may need to focus on the underlying causes of the seizures, and on the control of other clinical features of malaria, such as hypoglycaemia, to identify more salient indicators of subsequent impaired growth and development.

The KDC is one of the first culturally appropriate measures for resource-limited settings available, accompanied by evidence of sound psychometric properties and affordable in the context for which it was designed. The main limitation of the current study is the absence of a normative group, consisting of healthy children. This population would have allowed for a more extensive evaluation of psychometric properties of KDC such as its sensitivity to the effects of cerebral malaria and its performance in a sample representative of the community. A study is currently underway to develop normative data for the KDC, establish its predictive validity, and to expand and modifying scales within the test to allow for greater sensitivity to specific disease effects.

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CHAPTER 2.2
MONITORING PSYCHOMOTOR DEVELOPMENT IN A RESOURCE-LIMITED SETTING: AN EVALUATION OF THE KILIFI DEVELOPMENTAL INVENTORY*

Abstract

Measures of child development that are reliable and valid for use in resource-limited settings are essential to the understanding of the longer-term consequences of ill health. The current article describes a study in which additional modifications were made to a locally developed measure, the Kilifi Developmental Checklist, to increase the cultural suitability of the final measure. The aim of the current study was to evaluate the psychometric properties of the new measure, the Kilifi Developmental Inventory (KDI). The KDI assesses psychomotor functioning of children below the age of 3 years. Two groups of community children (319 rural dwellers and 104 urban dwellers) and 9 children with neurodevelopmental disorders were involved in this cross-sectional study in Kenya. All were aged between 6 and 35 months. In a rural reference population the inventory showed excellent internal consistency (α = .96), inter-observer agreement (Intraclass Correlation Coefficient = .98), and test-retest reliability (Intraclass Correlation Coefficient = .96). These good psychometric characteristics were also found in an urban setting. Children with neurodevelopmental impairments had significantly lower scores compared to the community sample ($F(1, 113) = 165.07$, $p < .001$, $\eta^2 = .61$), attesting to the sensitivity of the measure. Mothers from the community reported that they found the assessment procedures acceptable and informative. The KDI is a culturally appropriate measure that can be used to monitor and describe the development of at-risk infants and toddlers in resource-limited settings in Kenya.

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An estimated 200 million children in developing countries fail to achieve their developmental and cognitive potential (Grantham-McGregor et al., 2007) due to exposure to multiple risk factors such as infectious diseases, malnutrition, and congenital problems (Olness, 2003). Early identification and intervention can reduce the impact of impairment (Simeonsson, 1991); however, a shortage of appropriate assessment tools hampers efforts to identify and monitor at-risk children in developing countries (Holding et al., 2004).

The use of standardized tests from Western countries seems to provide a quick solution to this shortage. However, the transfer of tests into a non-Western context is associated with significant limitations of interpretation (Greenfield, 1997). Three assessment approaches (called adoption, adaptation, and assembly) have been proposed to produce instruments that can be used in a non-Western context (Van de Vijver & Tanzer, 2004). *Adoption*, which involves the usage of closely translated versions of instruments developed and standardized for Western populations, may lead to assessment bias, constrict the within-population variance and mask true group differences (Grantham-McGregor, 1993). This bias may be due to a lack of familiarity with test demands (e. g., working with speeded tests) (Baddeley, Gardener, & Grantham-McGregor, 1995), poor translation of test items (Van de Vijver, 1997), unfamiliarity with test content (pictures and toys in infant assessment scales) (Boivin et al., 1995; Sigman, Neumann, Baksh, Bwibo, and McDonald, 1989; Sigman, Neumann, Jansen, & Bwibo, 1989), and differences in behavioural repertoire that define psychological constructs (Kambalametore, Hartley, & Lansdown, 2000). Through *adaptation* some features of the original instrument are retained and others changed to increase the suitability of the instrument to a new context. For both adopted and adapted instruments the psychometric properties and test norms have to be re-established to reflect the performance of cultural groups of children previously not included in the standardization sample, and to demonstrate the appropriateness of the new instrument. *Assembly* is the construction of a new assessment measure (Malda & Van de Vijver, 2005). This is the most extensive approach to developing assessment procedures for use in a new context. It is also relatively expensive and time consuming. However assembly can adequately address issues that pose potential threats to test validity such as suitability of test content, administration procedures, and task familiarity (Roselli & Ardila, 2003).

We have identified only two measures whose reliability and validity in the Kenyan context have been evaluated: the Kenya Screening Test for children 6 months to 6 years and the Ten Question Questionnaire (Muga, 2003; Mung'ala-Odera et al., 2004). Both measures are screening tools, tend to identify gross impairments and are likely to overlook children with mild developmental delays (Muga, 2003; Mung'ala-Odera et al., 2004). The current manuscript describes a study in which modifications to a locally developed instrument, the Kilifi Developmental Checklist (KDC) (Abubakar et al., 2007), were used to develop an

assessment of psychomotor performance appropriate for infants and toddlers in a resource-limited context. The original KDC assessed four domains of functioning; locomotor development, eye-hand coordination, social-emotional development, and speech and language development in children up to 9 years of age. Each scale demonstrated good psychometric characteristics (Abubakar et al., 2007). However, the original study did not include a reference group. Furthermore, we wanted a focused measure targeting only children aged less than 3 years old and assessing psychomotor development and not other areas of functioning. We also wanted to simplify the KDC's potentially complex and ambiguous scoring procedure and exclude test materials purchased in Europe so as to make the items accessible to local users.

The aims of the current study were: a) to evaluate the reliability, validity, and acceptability of the Kilifi Developmental Inventory (KDI), a modification of the KDC; b) to evaluate the applicability of the KDI for use in an urban community; c) to develop KDI reference tables to support the interpretation of individual child's performance and d) to evaluate the sensitivity and adequacy of the KDI in the identification of children with developmental impairments. Each of these aims was addressed in a separate study.

Methods

Study Sites and Study Samples

The studies took place at two sites. The first was the Kenya Medical Research Institute, Centre for Geographic Medicine Research (Coast), Kilifi, Kenya. Kilifi is mainly a rural area. The majority of the population in the area belongs to the Mijikenda ethnic/linguistic group. Most families in this rural community depend upon subsistence farming. Low literacy levels and high poverty levels characterize the population. Sixty-six percent of the population live below the poverty line (Government of Kenya, 2001). The study took place within a demarcated area in Kilifi that undergoes active four-monthly demographic surveillance, in which the births, deaths and movement of individuals are recorded. Children qualified for inclusion in this study if they met the following criteria: a) aged 6 to 35 months, b) parents spoke Kiswahili or one of the Mijikenda dialects as their primary language, c) children reported no chronic illness in the course of the study, d) families lived within the designated study areas, and e) parent gave informed consent.

Four government-run clinics, two in the northern and two in the southern study area, were used as focal points to recruit 70% of the rural study sample. The remaining 30% were recruited from the population that uses the, (only) tertiary level government hospital in the district, Kilifi District Hospital. The study area has more than 201 enumeration zones covering 15 locations. A list of eligible children in the 7 locations immediately around the clinics was generated. Random stratified sampling was used to identify and recruit study participants.

Stratification was based on age, gender and geographical area. We aimed at having 25 children for each age band with an equal representation of boys and girls. Age-bands were based on a 3 months grouping, the first band consisting of children aged 6, 7 and 8 months. Parents were approached for consent to recruit their children until the target number of children per strata was achieved.

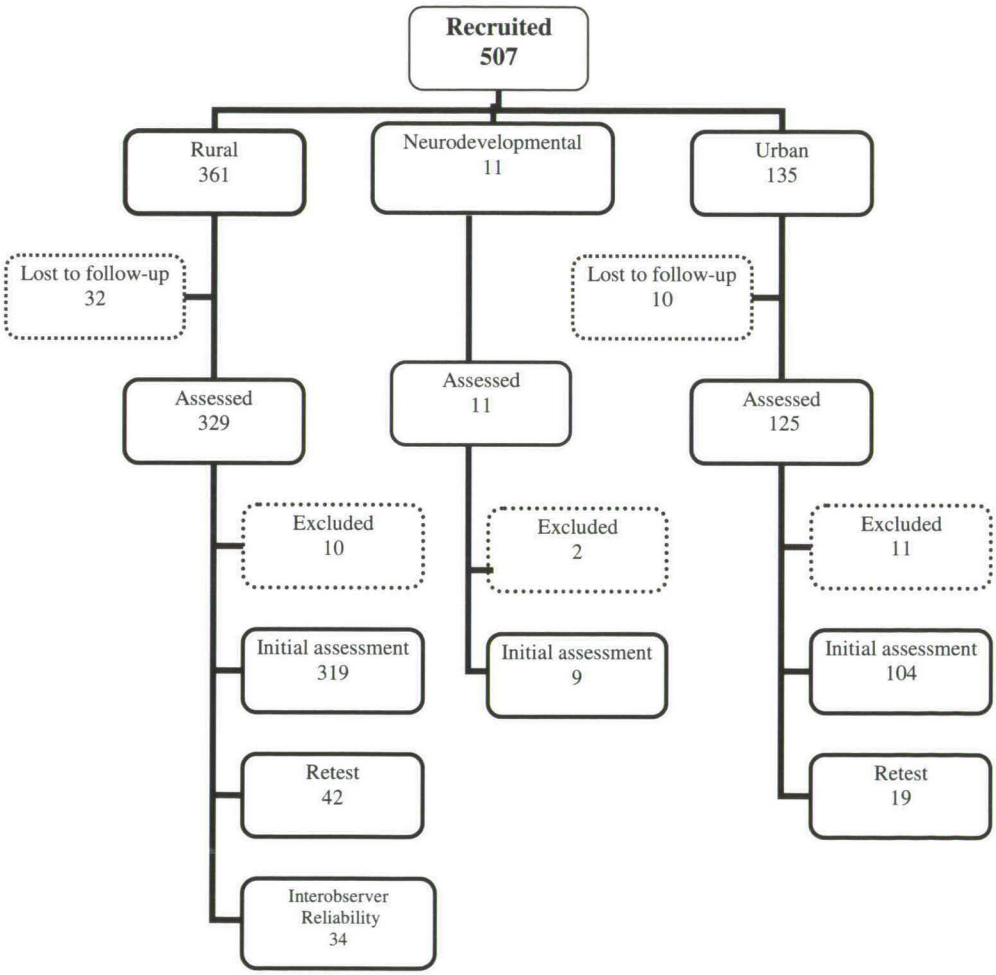
The second site was Kisauni Location, Mombasa District, which is an urban setting. Kisauni location has the second highest population of people living in poverty in Mombasa, with approximately 47% of the population living below the poverty line (Ministry of Planning and Development, 2001). Most of the poor are squatters living in informal settlements (Ministry of Planning and Development, 2001). The population consists of people from different ethnic and linguistic backgrounds; however, Kiswahili is widely spoken as a *lingua franca*. Identical inclusion and exclusion criteria to those described above were applied. A network of community representatives was used to identify and approach families with eligible children. A snowballing method was employed to identify other eligible children, whereby mothers identified other families with children in the target age group. Stratified sampling was used to recruit study participants. Stratification was based on age and gender. We again aimed at having 25 children for each 3-month age band with an equal representation of boys and girls. Children were approached for recruitment until the target number per strata was achieved.

Modifications to the Kilifi Developmental Checklist (KDC)

To address the limitations of the KDC four main phases of modification were carried out to develop the KDI. We began by focussing only on the assessment of psychomotor skills, excluding the components of the KDC that assessed language and social-emotional functioning. These latter two components were subsequently developed into separate measures. Next we audited the performance of children on the psychomotor items from the KDC (Abubakar et al., 2007) to focus on tasks appropriate for children aged 6-35 months. We excluded all items that had not been successfully completed by at least one child less than 36 months of age. We then expanded the range of items suitable for children 6-12 months by including items that focused on early movement.

The KDC had previously been administered in an adapted room within the hospital setting. We piloted the new KDI on a sample of 70 community children, age-range 6 to 35 months, to evaluate the suitability of the assessment to home-based administration. We used observations of these sessions to establish the order of test administration and to modify the scoring procedures. In the KDC each item was scored on a three-point scale (0- cannot do the task; 1- skill emerging; 2- skill established). These scoring procedures were simplified and dichotomized (0- cannot perform the task; 1- can perform the task) to reduce the potential for ambiguity.

Figure 1. *Sample Description*



The Kilifi Developmental Inventory (KDI)

The KDI consists of 69 items, administered by an assessor who explains and demonstrates for the child each new task prior to the child attempting the activity. A summated score is calculated for two functional areas, locomotor skills and eye-hand coordination, which can be combined to provide an overall psychomotor score. Locomotor items assess the child's movement in space, static and dynamic balance, and motor coordination. Items include ball and reaching skills, mobility in prone position, supine positions and standing, development in climbing, and jumping. Eye-hand coordination assesses the child's ability to

manipulate objects and to co-ordinate fine motor movement. Items include manipulation of coins, bead threading and block building. A detailed instructional manual was produced through an interactive process with the assessment team, standardizing the administration procedure in the language of the assessment. The manual includes templates for constructing standardized test materials.

Procedure: The assessment team was trained by two psychologists (Abubakar and Holding) assisted by a physiotherapist. This involved a two-week familiarisation and skill-training workshop followed by practice in the field. The field-based training covered an extended period of 10 weeks, incorporating a pilot study of 70 children on the new KDI and other infant assessment procedures (to be described elsewhere). Fieldwork was carried out between September 2004 and June 2005. Children were seen at home accompanied by their primary caretakers. Families were informed of the scheduled assessment at least two days before the visit by the team.

Analysis: Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. To evaluate reliability, Cronbach's alpha was computed to evaluate internal consistency while Intraclass Correlation Coefficients (ICC) were used to compute inter-observer and test–retest reliability. Pearson Product Moment Correlations were computed to evaluate criterion validity and sensitivity to age. Sensitivity to neurodevelopmental impairments was evaluated using analysis of variance, with age as a covariate; partial eta squared was used to estimate effect size. Content analyses of the transcripts of the focus group were conducted to evaluate the scales' acceptability in the community.

Ethics: The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Written informed consent was obtained from all families of study participants. The consent form was read out to parents in the language with which they were most familiar. Prior to seeking individual consent, we held a series of meetings with elders and community leaders to inform them of the study aims and obtain permission to work in their communities.

Study One: Evaluation of the Reliability, Validity, and Acceptability of the KDI in a Representative Rural Community Sample. The aim of the first study was to evaluate the psychometric properties of the KDI.

Sample: The rural sample consisted of 319 children (159 girls) with a mean age of 19.06 months (*SD* = 8.46, range: 6-35 months). A random sample of 34 (18 girls) children was selected from the main sample to be involved in the evaluation of inter-observer reliability. The mean age in this sub-sample was 17 months (*SD* = 8.4; range: 6-34 months). Inter-observer reliability involved two members of the assessment team scoring a child's performance simultaneously. Another randomly selected sub-sample of 41 children (21 girls) was involved in the evaluation of test-retest reliability. The age range of these children was 7-24 months with a

mean of 24 months (SD = 8.0). The mean test-retest interval was 4 weeks, with a range of 3-7 weeks. An effort was made to ensure that the same assessor saw the child at test and retest although this was not always possible due to logistical reasons. 71% of the children were seen by the same assessor for test-retest while 29% were seen by a different assessor.

Criterion validity was evaluated comparing performance on the KDI in the youngest age band to a developmental report elicited from the children's parents. These data were collected as part of a longitudinal study monitoring growth and development of a subset of children over a ten-month period, involving 87 children (47 girls) with a mean age of 9 months (range: 5-15 months). The mean interval between parental report and KDI assessment was 1 week (range: 1-3 weeks).

Measures: In addition to the KDI, the Developmental Milestones Form was administered to parents of children in the criterion validity arm of this study. The Developmental Milestones Form was also developed in Kilifi, as part of a schema for monthly monitoring of infants at-risk. The development and psychometric properties of this checklist are reported elsewhere (Abubakar et al, Submitted). The Developmental Milestones Form is made of 66 items in three main domains: motor, language and personal-social development. A trained community health worker completes it through an interview with the child's main caretaker. Summated scores are calculated for each domain separately; in addition, an overall developmental score can be computed.

Results: The values of the different aspects of reliability of the KDI evaluated were all within acceptable range (Cicchetti, 1994). High internal consistencies (Psychomotor: α = .96, Locomotor: α = .92, Eye-hand: α = .93) were found. Raw scores were used to compute ICCs (consistency) to estimate test-rest reliability (Psychomotor score: .96; Locomotor: .87; Eye-hand: .95); ICC (absolute agreement) were applied to evaluate Inter-observer reliability (Psychomotor: .98, Locomotor: .92, Eye-hand: .94). The values were excellent.

A t test indicated there were no significant differences between the psychomotor performance of girls and boys (M = 35.89, SD = 13.08 and M = 36.25, SD = 12.28 respectively), $t(319) = 0.34$, $p = .73$. The absence of gender differences was confirmed at the sub-scale level (Locomotor: M = 16.30, SD = 6.22 and M = 16.18, SD = 6.41 respectively, $t(319) = 0.30$, $p = .75$; Eye-Hand: M = 19.95, SD = 6.36 and M = 19.72, SD = 6.83 respectively, $t(319) = 0.36$, $p = .71$). Consequently, gender was not considered in the remaining analyses.

As can be seen in Table 1, significant relationships with parental report of child functioning were observed, providing support for criterion validity. As expected, the KDI had the strongest relationship with the Developmental Milestones - motor scale at $r(87) = .84$, $p < .001$.

Table 1. *Correlations between the Psychomotor Scales and Parental Report*

	Psychomotor scores		
Parental report	Locomotor	Eye-hand	Psychomotor
Motor	.84**	.73**	.83**
Language	.63**	.60**	.64**
Personal social	.55**	.50**	.57**
Total score	.80**	.72**	.80**

$^{**}p < .01$.

The acceptability of the measures as viewed by the community was evaluated through a series of focus group discussion. Mothers felt that the measures had high face validity and that the performance of their children on the tasks presented adequately characterised their child's developmental level. Another common theme to emerge was the value mothers placed on the opportunity to observe their child's participation in the assessment sessions. The opportunity to make a detailed observation of their child's individual functioning helped to demonstrate to them developmental stages. In addition, they reported that involvement in the assessment session provided suggestions of activities and materials that families can use to stimulate their children. Mothers indicated that they found the test to be of sufficient value to be willing to participate in future assessments.

Study Two: Evaluation of the Performance of the Kilifi Developmental Inventory in an Urban Community. The applicability of the KDI for use with children from an urban environment was evaluated by comparing the performance of children from Kisauni with those of the rural children reported above.

Sample: This study included two groups of children aged between 24-35 months. The first group consisted of 104 children (53 girls) sampled from the urban population. The mean age was 29.11 months (SD = 3.53; spread: 24-35 months). The comparison group consisted of the data from all children aged 24-35 months previously included in the rural sample (N = 99 children). The mean age was 29.47 months (SD = 3.53; spread: 24- 35 months).

Materials and Procedures: The same assessment team that administered the KDI in the rural sample was involved in the data collection in the urban sample. Children were seen at home accompanied by their caretakers. The evaluation of test-retest reliability was made using a randomly selected sample of 19 children, visited after a 3-week interval.

Results: A t test was performed to compare the scores of the 24-35 months age groups of rural vs. urban residence (Kilifi vs. Kisauni sample). Results indicated no significant differences in the psychomotor scores of the rural (M = 49.12, SD = 5.11) and urban population (M = 48.07, SD = 5.39), $t(204) = 1.25$, p = .21. Subscale scores confirmed the absence of any significant differences between the groups (Locomotor M = 22.97, SD = 2.91, and M = 22.16, SD = 2.89

respectively, $t(204) = 1.56$, $p = .12$; Eye-Hand, $M = 26.73$, $SD = 3.12$, and $M = 26.35$; $SD = 3.34$ respectively, $t(204) = 0.73$, $p = .46$).

The internal consistency for the scale in the urban sample was excellent (Psychomotor: .87, Locomotor: .77, Eye-hand: .80) and fell within the confidence intervals of the alpha's from the Kilifi group indicating their internal consistencies were analogous (Psychomotor: .84, Locomotor: .74, Eye-hand: .77)

Additional *t* tests indicated that there were no significant differences between the performance of girls and boys in the urban sample (psychomotor score girls, $M = 49.05$, $SD = 5.88$, and boys, $M = 47.96$; $SD = 5.64$), $t(104) = 0.91$, $p = .91$. The subscale showed the same pattern of results (Locomotor: girls, $M = 22.41$, $SD = 2.86$, and boys, $M = 21.90$; $SD = 2.93$ $t(104) = 0.90$, $p = .77$; Eye-Hand: girls $M = 26.64$, $SD = 3.12$, and boys $M = 26.05$; $SD = 3.58$ $t(104) = 0.88$, $p = .45$). Similar results were obtained in the age-equivalent rural sample (Psychomotor: $M = 49.26$, $SD = 5.29$, and $M = 50.21$; $SD = 5.14$, $t(99) = 0.89$, $p = .37$) The subscales showed the same pattern of results (Locomotor: $M = 23.31$, $SD = 2.98$, and $M = 22.67$; $SD = 2.83$, $t(99) = 1.10$, $p = .27$; Eye-Hand: $M = 26.89$, $SD = 3.16$, and $M = 26.59$; $SD = 3.1$, $t(99) = 0.47$, $p = .63$).

Intraclass correlation coefficients, measuring consistency, were used to evaluate the test-retest reliability of psychomotor scales. These values, again, were excellent (Psychomotor: .91, Locomotor: .82, Eye-hand: .88).

The Development of Reference Tables: Reference tables, showing the expected range of performance in each age group, were computed. These tables enable practitioners to identify at-risk children by comparing the scores of an individual child with appropriate age-related performance levels.

Sample: The comparability of test performance between the urban and the rural population implies that the data of both the rural and urban groups can be combined to create a single reference table. Therefore, 423 children (girls 212) are included in the reference population. The mean age in the reference population is 20.89 ($SD = 8.73$; range: 6-35 months).

Procedure: We first examined the effect of age by correlating the raw scores with age. A table of *Developmental Age Equivalent* scores was then created using a procedure adapted from the Bayley's Scale of Infant Development (Bayley, 1993). In this procedure the median of each age band is computed and the scores falling between two adjacent medians are divided into two groups. The scores in the lower half are added to the median of the lower age band while scores in the upper half are added to the median of the upper age band to create the upper and lower levels of adjacent age bands. When the interval difference is an odd number, the larger of the two divisions (e g. 4 of 7) should be added to the lower age band. The age appropriate range of scores for any age band is thus defined by the median +/- the differences between it and the adjacent medians. Developmental age can then be expressed as the mean of the age band in which a child's score falls, plus or minus 1 month. For instance, the developmental age for

a child functioning within the scores of age band 6-8 months is 7 ± 1 month. A second table; *the reference table,* was also created. This table can be used to classify levels of functioning in children. Mean scores and standard deviations for each age bands were used in the computation of this table.

Results: As can be seen in Figure 2 and Table 2, an increase in mean scores with age was found. The mean score for the youngest age band (6-8 months) was 15.86 (SD = 2.9) while that for the oldest group (33-35 months) was 53.06 (SD = 3.6). This represents an increase of approximately 13 standard deviations between the youngest age group and the oldest one. The correlation between age and the psychomotor score was highly significant: $r(423) = .93$, $p < .001$ explaining approximately 86% of the variance. Similar trends were observed in the subscales (Locomotor: $r(423) = .89$, $p < .001$, variance explained: 79%; Eye-hand: $r(423) = .92$, $p < .001$, variance explained: 85%). As can also be seen in Figure 2 the rate of gain changes over time, and is characterized by rapid gain in the younger bands. After 18 months of age performance improves more slowly.

Table 2. *Means and Scores per Age Band*

Age bands[a]	*N*	Min.	Max.	*M*	*SD*
6-8	29	11	24	15.86	2.97
9-11	34	14	26	20.44	2.50
12-14	57	19	40	27.35	4.56
15-17	37	22	42	34.29	5.64
18-20	41	31	50	40.29	3.09
21-23	22	39	49	43.63	2.68
24-26	60	37	55	44.85	3.84
27-29	39	32	58	48.28	4.95
30-32	54	39	60	50.75	4.95
33-35	50	41	60	53.06	4.55

[a] age in months.

Two tables are provided to guide the interpretation of an individual child's Psychomotor Score. As described earlier a child's developmental age can be reported by using Table 3 to convert the child's raw score to a developmental age equivalent score. In addition the child's performance level can be classified by locating the raw score in the appropriate age band in Table 4. A child whose total score falls within 1 *SD* of the mean of his/her age band is said to be performing within the normal range. A child whose score falls at or below -2 *SD* but above -3 *SD* is reported to be experiencing a moderate delay in performance. While a child who's score falls at or below -3 *SD* is taken to be experiencing a severe delay in performance.

Figure 2. *Means and 95% confidence intervals (CI) for the three-month age bands*

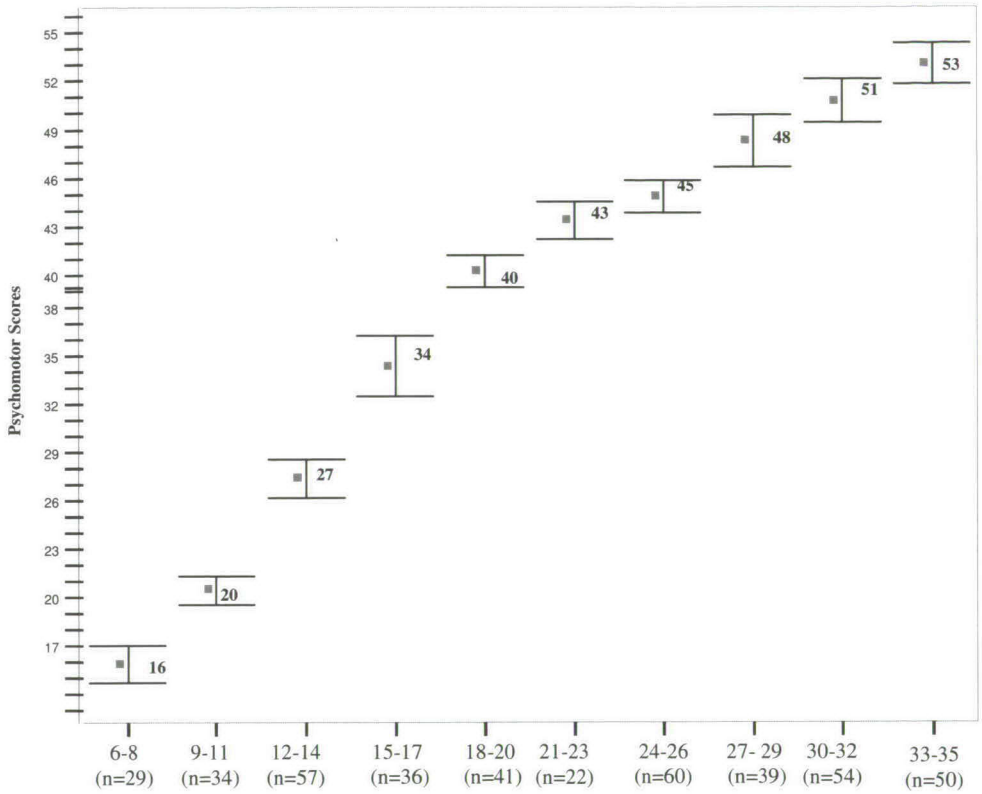


Table 3. *Total Scores and Equivalent Developmental Age*

Developmental Age (in months)	Range of Scores
< 6 months	0-16
7 ± 1	17-19
10 ± 1	20-24
13 ± 1	25-33
16 ± 1	34-38
19 ± 1	39-42
22 ± 1	43-44
25 ± 1	45-47
28 ± 1	48-50
31 ± 1	51-53
34 ± 1	> 54

Table 4. *Levels of Performance*

Age-bands[a]	Superior Performance	Accelerated performance	Normal range	Moderate delay	Severe delay
	+3 *SD*	+2 *SD*	+1 *SD* to -1 *SD*	- 2 *SD*	-3 *SD*
6-8	25	22	19-13	10	7
9-11	29	26	24-18	15	12
12-14	42	37	32-23	19	14
15-17	51	45	40-29	23	17
18-20	50	46	43-37	34	31
21-23	51	49	46-41	38	35
24-26	56	53	49-42	38	35
27-29	61	57	53-44	40	35
30-32	66	61	56-45	40	35
33-35	65	61	57- 50	47	43

[a] age in months.

Study Three: Evaluation of the KDI in Identifying and Describing Children with Neurodevelopmental Impairment The main aims were to: a) investigate the sensitivity of KDI to early brain insult by evaluating its ability to identify true group differences; b) evaluate the level of agreement between the KDI and the schedule used by the Association for the Physically Disabled of Kenya (APDK) for identifying developmental delay, c) evaluate the ability of the KDI to identify variation in the performances of a low functioning group.

Sample: The study was carried out in two stages. Firstly, the performance of nine children attending a community-based rehabilitation programme for developmental delay, (including children with cerebral palsy: $N = 4$; idiopathic psychomotor delays: $N = 3$; hemiplegic: $N = 1$; hydrocephalus: $N = 1$) was compared to the reference scores provided by the 104 children in the urban sample described in the second study to evaluate KDI's ability to identify true group differences. Children from the rehabilitation programme (hence forward referred to as group 1) qualified for inclusion in this study if they did not have severe neurosensory impairments, such as visual and hearing impairment, that restricted their ability to interact with the materials provided. The mean age of group 1 was 28 months ($SD = 3.5$; range: 24-34 months).

To assess sensitivity and specificity between two different approaches to assessment the performance of children from group 1 was compared to that of children from the urban reference group selected to represent the highest and lowest performers in the group (to be referred to as group 2). Group 2 numbered 18 children, with a mean age of 29 months ($SD = 3.0$, range: 24-35 months).

Materials and procedures: Children from group 1 and 2 were administered the KDI by the study team and the observational schedule used by the APDK to identify children in need of rehabilitation. The APDK schedule consists of three parts: family background, health history and developmental skills. Data are collected through a combination of parental report and observation. An

occupational therapist and a community rehabilitation fieldworker administered this latter schedule.

Results: Significantly lower performances on the KDI by children with neurodevelopmental impairment (group 1) were observed for the age corrected standardized psychomotor scores compared to the community sample (M = -2.61, SD = 1.30 and the M = 0.23, SD = .55 respectively), $F(1, 113) = 165.07$, $p < .001$, $\eta^2 = .61$). A similar pattern of scores was found at the subscale level (Locomotor scale: M = -2.64, SD = 1.03, M = 0.23, SD = 0.58, $F(1, 113) = 175.53$, $p < .001$, $\eta^2 = .61$; Eye-hand: M = -2.38, SD = 1.60, M = 0.20, SD = 0.57, $F(1, 113) = 112.13$, $p < .001$, $\eta^2 = .50$). The scores on the KDI indicated variation in performance of children in group 1. The age-corrected unstandardized psychomotor scores ranged from -41.27 to -5.43 and had a mean of -24.80 (SD = 11.28). This variation in performance was also observed for the subscales (Locomotor scores had a minimum of score of -18.74 and a maximum of -2.75 and a mean of -13.36 (SD = 4.79) while the Eye-hand score had a minimum of score of – 22.5 and a maximum of -2.68 and a mean of -11.45 (SD = 7.07). Ninety percent (N = 8) of the children with neurodevelopmental impairment were identified as functioning below the 10th percentile on the KDI compared to only 9% (N = 10) of the urban community children.

To compare the KDI to the APDK approach in identifying developmental delay we looked at the level of agreement in the two approaches in categorising developmental impairment in children from groups 1 and 2 (N = 27). The level of agreement between KDI and the APDK was 89% (N = 24). Two children identified by the KDI approach as having a developmental impairment were not so identified by the APDK, while one child identified by the APDK was not picked up by the KDI.

Discussion

The purpose of this study was to evaluate a modified version of a locally developed measure of psychomotor functioning in its application to the assessment of children aged 6 to 35 months. We wished to establish its reliability and validity within a reference group of children from both a rural and urban setting, as well as the sensitivity of the measure to within population variance at all levels of functioning. Results indicate the scale is reliable, reflects maturational changes and is able to identify children with developmental delay. The results support the reliability and validity of the scale (Kline, 1993; Nunnally & Bernstein, 1994). Our study shows that it is possible to develop a culturally appropriate measure of psychomotor development that has sound psychometric properties. Furthermore, the present study confirms the results of earlier applications suggesting the sensitivity of the measure to early brain insult (Abubakar et al., 2007; Barlow, Mung'ala-Odera, Gona, & Newton, 2001; Gordon, English, Tumaini, Karisa, & Newton, 2005). Moreover, the good

psychometric properties observed in the current study indicate that the modification carried out to the original checklist did not compromise the validity and reliability observed with the earlier version (KDC).

Adequate criterion validation requires the use of a gold standard as the criterion measure (Gregory, 1992). We did not have such a measure, but were able to compare the extent to which the KDI, completed in a single test session by a person unfamiliar with the child, correlated with parental reports of child functioning. The significant correlation between the two approaches provides initial support for criterion validity. There are inherent limitations in both performance-based assessments and parental report of child functioning. Parental reports may lack reliability and validity while performance-based assessment has been criticised for sampling child behaviour in a single session, which may lead to an underestimation of a child's real abilities. Future studies should focus on evaluating the feasibility of combining the two approaches to ensure that the performance level recorded is a true representation of the child's ability (Carter, Briggs-Gowan, & Davis, 2004).

As in most parts of Africa, we work in an area where psychological assessment is relatively new. The relative unfamiliarity of assessment procedures may make them unacceptable to community members. Parental evaluation of the measure during focus group discussion confirmed however the acceptability of the procedures here described to the local community. Community acceptability is another feature of test validity that is rarely investigated, but has important implications for the recruitment and retention of study participants.

In developing the Kilifi Developmental Inventory care was taken to include tasks and test format familiar to children in a rural African community. Both this study and previous applications of the KDC confirm the suitability for the rural population of the tasks and materials included in the inventory (Abubakar et al., 2007). The current study provides evidence that the test is also suitable for application to other settings, in particular to economically-deprived urban and peri-urban locations. The tasks and procedures were directly transferable, and our experience suggests that the KDI may therefore be suitable for use in other African settings. The close similarity in the distribution of scores also suggests that it will be possible to develop reference tables applicable across a wider geographical region, beyond that of coastal Kenya, although more detailed investigations would be needed before the extent of the applicability of the reference tables is clarified.

The measurement tools currently in use in Kenya are shorter and therefore less time consuming than our measure (Muga, 2003; Mung'ala-Odera et al., 2004). However, these measures are essentially screening tools and identify only severe impairment, whilst the KDI, with a more extensive range of items, is also able to identify mild developmental problems. Furthermore, the KDI was able to reveal individual differences even in the low functioning group. This suggests that

the tool could prove valuable in monitoring rehabilitation programmes for children by identifying smaller changes in performance than alternative screening tools.

Problems with applying and adapting standardised instruments from Western countries in Africa often begin with the prohibitively high price of western materials (Aina & Morakinyo, 2001). The KDI consists of test materials that are relatively cheap and easy to produce locally. The estimated cost is USD 60 per kit. A detailed manual on test administration, including a guide on constructing a standardized set of test materials has been produced. This ensures affordability and accessibility of test content to a wider group of people interested in psychological assessment in resource-poor countries.

The absence of a large enough sample to compute normative data may limit the applicability of the reference tables. Another potential limitation is the restricted age range in the urban sample. It may be that children in urban areas develop at a different rate and that a different pattern of results would have been observed in the younger age group. Despite these potential concerns, given the scarcity of data on psychological assessment from sub-Saharan Africa this represents a good first step in providing validated measures of childhood outcome in this region. We were also able to demonstrate that the development of the tables allowed for a meaningful interpretation of data from individual children. Given the cost of developing a normative group, future efforts could focus on collating data from more than one source to allow for the development of standardized scores. Future efforts also need to investigate the use of the KDI in a wider range of clinical groups, including larger numbers of children at risk.

The Kilifi Developmental Inventory is a locally assembled and culturally appropriate measure of psychomotor functioning that can be used to identify, describe and monitor effects of biological risk in children less than 3 years of age. It can be cheaply produced, can be administered by assessors with limited background in child development, and the approach is acceptable to local communities making it a suitable option for resource-limited settings. Moreover, it appears appropriate for use both for clinical and research purposes.

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CHAPTER THREE

Anthropometry and Outcome

CHAPTER 3.1
SOCIOECONOMIC STATUS, ANTHROPOMETRIC STATUS, AND PSYCHOMOTOR DEVELOPMENT OF KENYAN CHILDREN FROM A RESOURCE-LIMITED SETTING: A PATH-ANALYTIC STUDY*

Abstract

The aim of the study was to determine if anthropometric status mediates the relation between socioeconomic status and psychomotor development of young children in a resource-limited setting. This cross-sectional study involved 204 (105 girls) children from two resource-limited communities in Coast Province, Kenya. The mean age of these children was 29 months (*SD* = 3.43; range: 24-35 months). Psychomotor functioning was assessed using a locally developed measure, the Kilifi Developmental Inventory. While a significant association was found between anthropometric status (as measured by weight-for-age, height-for-age, mid-upper arm circumference and head circumference) and psychomotor functioning, no direct effects were found between socioeconomic status and developmental outcome. The models showed that weight, height and to a lesser extent mid-upper arm circumference mediate in the relation between socioeconomic status and developmental outcome, while head circumference did not show the same effect. Among children under 3 years living in poverty, anthropometric status shows a clear association with psychomotor development while socioeconomic status may only have an indirect association.

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* Abubakar, A., Van de Vijver, F. J. R., Van Baar, A. L., Kalu, R., Mbonani, L., Newton, C. & Holding, P. (2007). Socioeconomic Status, Anthropometric Status, and Psychomotor Development of Kenyan Children from a Resource-Limited Setting: A Path Analytic Study. (Revisions to be submitted: Early Human Development).

Many children living in resource-limited settings have poor developmental outcome (Olness, 2003). Sub-optimal physical growth is suggested as a key pathway between the effect of environmental risk and developmental outcome (Bradley & Corwyn, 2002). Using structural equation modelling, the current study investigates the mediational role of anthropometric status in the relationship between socioeconomic status and psychomotor development of children from a resource-limited setting.

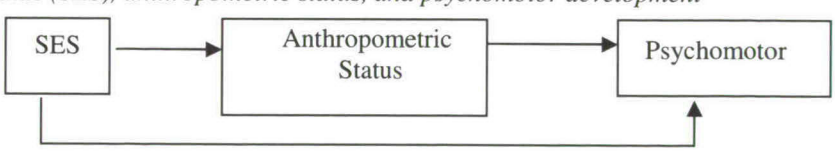
Poor physical growth is prevalent in developing countries, where approximately 38% of children are underweight and 42% stunted (Olness, 2003), compared to approximately 2% and 1% being underweight and stunted in the USA (UNICEF, 2006). The most vulnerable group of children with the highest prevalence of growth restriction are those under five years of age (World Health Organization Expert Commitee, 1995). Growth restriction in the early years of life increases the risk of mortality (Black, Morris, & Bryce, 2003), morbidity (Agarwal et al., 1992), and developmental delay and impairments (Benefice & Malina, 1996; Kuklina, Ramakrishna, Stein, Barnhart, & Martorrell, 2004; Siegel et al., 2005).

Restricted social and economic resources have been associated with poor growth (Connolly & Grantham-McGregor, 1993; O'Donnell & Grippo, 2004; Walker, Grantham-McGregor, Powell, & Chang, 2000) and with poor developmental outcome (Bradley & Corwyn, 1996, 2002). It is difficult to ascertain a causal link between poverty, growth, and outcome. The few studies that addressed the relationship between socioeconomic factors, growth, and psychomotor development consistently reported significant relationships between all three variables (Sigman, Neumann, Jansen, & Bwibo, 1989; Vazir, Naidu, & Vidvasagar, 1998). However, these studies only address the correlation between the variables and do not investigate the potential pathways to poor developmental outcome. In the only path analytic study of the relationship between socioeconomic status (SES), height-for-age (HAZ) and Motor Skills we identified, Pollit and Walka (2002) present a preliminary model of the relationship between the 3 variables among 12 and 18 month-old children in Indonesia. They report a significant relationship between SES and HAZ, and between HAZ and Motor Skills. However, this study addressed only direct effects and did not address more complex patterns of associations such as mediation. Partial mediation occurs if an input variable (e. g., socioeconomic status) influences the outcome both directly and indirectly through an intervening variable (e. g., HAZ). Full mediation is found when the input variable has only a link with the outcome variable through the intervening variable. We extend the findings from earlier reports by investigating whether the influence of SES (the predictor) on psychomotor development is partly or fully mediated by anthropometric status.

Each measure of anthropometric status applied represents a different form of nutritional deprivation and potentially different etiology (Frongillo Jr, de Onis, & Hanson, 1997). The HAZ scores below -2 *SD* are associated with stunted growth, which in turn reflects chronic malnutrition. Weight-for-age (WAZ) below -2 *SD* is associated with low body mass, reflecting acute malnutrition, while head circumference-for-age (HCZ) is sensitive to the effects of chronic undernutrition, but is more closely related with genetic factors (Gale, O'Callaghan, Godfrey, Law, & Martyn, 2004; Ivanovic et al., 2004; Silva, Metha, & O'Callaghan, 2005) and can be influenced by perinatal insults such as birth asphyxia. Mid-Upper arm circumference-for-age scores (MUAC/A) below -2 *SD* is associated with wasting which is an indication of acute malnutrition and severe growth disturbances.

The applicability of the model shown in Figure 1 is tested for each measure of anthropometric status taken. The model holds that SES has both a direct and indirect effect on psychomotor development. This model is based on the hypothesis that children with lower SES experience a higher prevalence of poor anthropometric status and show less advanced psychomotor development than children from higher SES. Furthermore, children with poor anthropometric status are expected to have lower levels of psychomotor skills compared to those with normal anthropometric status.

Figure 1. *Hypothesized mediational model of the relationship between socioeconomic status (SES), anthropometric status, and psychomotor development*



Method

Study Setting

The study took place at two sites. The first site was the Kenya Medical Research Institute, Centre for Geographic Medicine Research (Coast), Kilifi, Kenya. Kilifi is situated in a predominantly rural community. The majority of families depend upon subsistence farming with approximately (67%) of the population in the district living below the poverty line (Ministry of Planning and Development, 2001). The majority of the population in Kilifi belong to the Mijikenda ethnic/ linguistic group. Two Bantu languages are mostly spoken in the area namely Kigiriama (a member of the Mijikenda group of languages) and Kiswahili. A typical home in Kilifi comprises a large homestead with several small huts built in the compound. In these homes extended families live together and share in the daily chores such as cooking and fetching water. It is typical for homesteads to have members of three different generations where they share in

childrearing duties. In this community intergenerational relationships are strictly regulated. For instance, parents largely play a disciplinary role and hence do not pay attention to children's play. Most of the times parents spend time with children administering functional duties such as feeding and washing. The time spent with children and activities with children is moderated by age. Children who have been weaned spend less time with the mother. These children will spend a large amount of time with older siblings who actively participate in child rearing. For instance, in this community only 35% of mothers keep their children within visual range when they are 24-35 months old; the rest of the time another person, often a sibling, does this. The study took place within a demarcated area in Kilifi District that undergoes active, four-monthly demographic surveillance, in which the births, deaths, and movements of individuals are recorded.

The second site was Kisauni location, a peri-urban site in Mombasa District. Mombasa is Kenya's second biggest city with a population of approximately 665,000 people (Government of Kenya, 2002). In Kisauni location approximately 47% of the population live below the poverty line, many as squatters living in informal settlements (Ministry of Planning and Development, 2001). Unlike in Kilifi, this site is much more metropolitan with a more diverse ethnic make-up. However, Kiswahili is widely spoken as a *lingua franca*. Most families live in single rooms as nuclear rather than extended families, sharing facilities such as water and toilets with other tenants. Furthermore, space is much more limited in Kisauni. In the absence of extended families mothers are much more vigilant; 70% of them indicated that they kept the children within visual range at 24-35 month. This may restrict child movements and range of play. Help for child care is largely provided either by a hired 'ayah' (maid) or an older sibling or neighbour.

Sample Description

This study was part of a larger study carried out to develop a reliable and culturally acceptable infant monitoring programme, containing measures sensitive to the social and biological risks faced by children in resource-limited settings. The main study involved 423 children aged between 6-35 months. Children were identified and recruited through stratified random sampling. Stratification was based on age, gender, and location. In Kilifi, children were identified through a database maintained at the Centre, while in Kisauni village elders were used to identify households with eligible children. Children qualified for inclusion if they met the following criteria: a) aged between 24 and 35 months; b) their parents spoke either Kiswahili or a Mijikenda dialect as their primary language; c) they reported no chronic illness in the course of the study; d) parents gave informed consent. All the children aged 24-35 months (N = 204) in the main study were eligible for inclusion in this study. We focused on this age group for several reasons. By 24 months of age the influence of environmental factors becomes

more prominent (Richter & Grieve, 1991) and the length of children below the age of 2 years are measured recumbent, while the older group is measured standing. This change in measuring method may lead to an overestimation of growth problems in an age group if we include scores from both age groups in one analysis, concentrating on one group may reduce this bias. The sub-sample studied here included 204 children (105 girls). The mean age of these children was 29 months (*SD* = 3.49; range 24-35 months).

Measurements

Kilifi Developmental Inventory: This scale is part of a locally developed and validated measure of infant development. The KDI consists of 69 items, scored from observation of children's performance on a range of activities. An assessor initially provides instructions and demonstrations for the child to model (Abubakar et al., 2007; Abubakar et al, submitted). A sum score is calculated for two functional areas, locomotor skills and eye-hand coordination. These can also be combined to provide an overall psychomotor score. Locomotor items assess the child's movement in space, static and dynamic balance, and motor coordination. Items include ball and reaching skills, mobility in prone position, supine positions and standing, development in climbing, and jumping. Eye-hand coordination assesses the child's ability to manipulate objects and to co-ordinate fine motor movement. Items include manipulation of coins, bead threading and block building. Items were scored on a dichotomous scale (0: child cannot perform the task, 1: child can perform the task). Table 1 summarizes the psychometric properties of this measure in the current sample.

Table 1. *Psychometric Characteristics of the Kilifi Developmental Inventory*

Statistics	*N*	Locomotor	Eye-hand	Psychomotor
Maximum possible score		35	34	69
Means (*SD*)	204	22. 48(2.96)	26.52 (3.26)	49.00 (5.59)
Alpha	204	.76	.78	.86
Retest reliability (*ICC*)	42	.61	.80	.83
Correlation with age(r)	204	.42**	.62**	.59**
Correlation with gender[a]	204	.01	.06	.03

SD: Standard deviation. *ICC*: Intraclass Correlation Coefficient (absolute agreement). *N*: Sample size. [a]Gender coding: girl = 1, boys = 0. $^{**}p < .01$.

Socioeconomic status. Two SES measures are used: wealth index and maternal education. Wealth index was measured using an adapted version of Kenya Demographic Health Survey SES measure (Central Bureau of Statistics, 2004), which lists material assets such as ownership of land, and non-material assets, such as maternal education. A single score was generated through principal component analysis. To take into account local variations in environmental factors only the 13 items from the original study that showed variation within this population, and had a salient loading on the one-factor solution found in a factor

analysis of the items were retained. A higher factor score indicated a higher SES. See Table 2 for a summary of items included, spread of scores and their factor loadings. Maternal education was operationalized as the number of years the mother attended formal schooling. The mean maternal education in this population was approximately 4.81 years of schooling (*SD* = 3.95; spread 0-14 years).

Table 2. *Items in the SES measure*

	% of population in each category of ownership (key below)				
	0	1	2	3	Factor loading
Radio	45.1	54.9			.37
Telephone	79.3	20.7			.46
Bicycle	62.2	37.8			.45
Electricity	82.4	17.6			.57
Television	82.4	17.6			.59
Availability of water [a]	21.2	78.8			.58
Mother's education [b]	32.1	20.7	36.3	10.9	.61
Type of window [c]	29.0	9.8	59.1		.64
Availability of toilet facilities [d]	31.1	71.0			.67
Livestock [e]	59.1	27.5	13.5		.66
House ownership	38.3	61.7			.75
Land ownership	38.3	61.7			.75
Material used on the floor of the house [f]	58.5	41.5			.83

KEY: [a]0 = Access to water in > 15 minutes; 1 = Access to water in < 15 minutes; [b]0 = no education; 1 = primary incomplete; 2 = primary complete; 3 = secondary incomplete. [c]0 = no window; 1 = Open window; 2 = all other windows (e. g., mesh wire, glass). [d]0 = no toilet and uses the bush; 1 = Toilet facilities available.[e]0 = none; 1= some; 2 = many. [f]0 = lives in a house with a mud floor; 1 = lives in a house with other types of floor materials;

Anthropometric: Height was measured standing, using a Leicester Height measure. Two trained assistants following the CDC recommended protocol for taking height measurements took the measures. Children were undressed and weighed on a SECA Digital Scale. Weight was recorded following at least three measures that provided a consistent result to at least one decimal point. Weight-for-Age and Height-for-Age standards were generated using the WHO 2005 software for assessing growth and development 2006 version (World Health Organization, 2005). Growth restriction was defined as having a score below -2 *SD* of the WHO 2005 standards. For head circumference and mid-upper arm circumference, these new data were not available and therefore EPI info (3.3.2) and the WHO/CDC 1978 reference were used to compute the *z* scores.

Procedure

Children were seen at home accompanied by their primary caretakers. Each child was assessed by a team of two experienced assessors, trained in the assessment procedures prior to the data collection process. These assessors carried out the assessment of developmental outcome and took anthropometric measures.

Data Management and Analysis Strategies

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. A *t* test was used to compute group differences while Cohen's *d* was used to estimate effect size. Amos 5 (Arbuckle, 2003) was used to compute the goodness of fit of the hypothesized path model. The fit of the overall model was evaluated using the chi-square statistic, which tests the exact fit of the model, as well as various other fit indices such as the Root Mean Square of Approximation (RMSEA), which measures the discrepancy between the predicted and observed models per degree of freedom and Tucker Lewis Index (TLI), which measures the similarity of the observed and hypothesized covariance matrix, adjusted for model complexity. We used full information maximum likelihood estimation, estimates of means and intercepts to accommodate missing SES data for 11 children. The model was tested with and without the subjects with missing data. Similar findings were observed and therefore we report data with all subjects included.

Ethics

The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Written informed consent was obtained from all families and guardians of study participants. The consent form was read out to illiterate participants in the language with which they were most familiar with before signing the consent form. Prior to getting individual consent, we held a series of meetings with elders and leaders within the communities to inform them of the study and get their permission and cooperation in working in these communities.

Results

Anthropometric Status

Approximately 49% (N = 100) of the children were stunted, and 19.6% (N = 40) underweight as measured by Height-for-Age (HAZ) and Weight-for-Age (WAZ) scores below -2 *SD,* respectively. Results indicate that rural children were more likely to be stunted (57%) than urban children (41.3%) were. A Pearson chi square test showed that this difference was significant ($\chi^2(1, 204) = 4.99$, $p = 0.03$). The difference in percentage of children who were underweight was not significantly different for the urban and rural group, (rural: 23%, urban: 16.3%; $\chi^2(1, N = 204) = 1.43$, $p = 0.23$). Head growth did not differ in the two groups either; poor head growth was found in 9.6% of the urban and 6% of the rural

children ($\chi^2(1, N = 204) = 0.92, p = 0.34$). Furthermore, the percentage of children with poor MUAC/A did not differ for the urban and rural group (rural: 16.2%, urban: 9.1 %; $\chi^2(1, N = 204) = 2.31, p = 0.13$). We did not observe any significant gender differences in anthropometric status. We therefore excluded gender from any further analysis.

Table 3. *Correlations between the Key Variables*

		1	2	3	4	5	6
1	Wealth index	1					
2	Maternal education	.62**	1				
3	Psychomotor scores	.03	.09	1			
4	Weight- for- age	.25**	.24**	.21**	1		
5	Height –for-age	.32**	.29**	.29**	.72**	1	
6	Head circumference	.07	.09	.18*	.48**	.36**	
7	MUAC/A	.19**	.18**	.14*	.72**	.37**	.31**

* $p < 0.05$. ** $p < 0.01$. MUAC/A -Mid- upper arm circumference

The Relationship between SES, HAZ and Performance

In the first model, wealth index was included as the SES indicator. The psychomotor scores of children who were stunted were significantly lower than those of children who were not stunted, $t(204) = 3.74, p < .001$, Cohen's $d = 0.52$ (see table 4 below). The hypothesized model (with paths from SES to HAZ, from HAZ to Performance, and from SES to Performance) was modified since the path coefficient between SES and psychomotor development was not significant ($\beta = 0.07, p = .32$). A new model without a direct path between SES and psychomotor development was then tested. The modified path analytic model showed a non-significant chi square fit value ($\chi^2(1, N = 204) = 0.96, p = .32, \chi^2/df = .96$), which points to an excellent fit. Other fit indices showed similar results, Tucker Lewis Index (1.00; recommended $\geq$ .90), and the Root Mean Square Error of Approximation (RMSEA) (.00; recommended $\leq$ .06). These values suggest a good fit of the data to the hypothesized model (Kline, 2005). The model indicates that SES is positively associated with height (standardized $\beta = .32$), which in turn is positively associated with psychomotor skills ($\beta = .29$).

The second model used maternal education as the SES indicator. Similar patterns of relationships between the variables as in the previous model emerged, with the path coefficient between maternal education and psychomotor development being insignificant ($\beta = 0.00, p = .97$). The modified path analytic model showed a non-significant chi square fit value ($\chi^2(1, N = 204) = .001, p = .97, \chi^2/df = .001$), which points to an excellent fit of the predicted and observed relationships. Other fit indices were excellent (TLI = 1.00 and RMSEA = .02), suggesting a good fit of the data to the hypothesized model. The model indicates

that maternal education is positively associated with height (standardized β =.29), which in turn is positively associated with psychomotor skills (β =.29).

Table 4. *Means and Standard Deviations on Kilifi Developmental Inventory Psychomotor Score for Children with and without Growth Restriction*

	N	*M* (*SD*)	T	*P*	Cohen's *d*
Height					
Stunted	100	-0.39 (1.03)	3.74	.000	0.52
Normal height	104	0.11 (0.90)			
Weight					
Underweight	40	-0.67 (0.97)	3.94	.000	0.70
Normal weight	164	-0.00 (0.96)			
Head circumference					
Small head size	16	-1.04 (1.09)	3.91	.000	1.02
Normal head size	188	-0.06 (0.95)			
MUAC/A					
Poor MUAC/A	26	-0.74 (1.01)	-3.40	.001	0.72
Normal MUAC/A	178	-0.05 (0.96)			

MUAC/A - Mid-upper arm circumference-for-age

The Relationship between SES, WAZ and Performance

The psychomotor scores of children who were underweight were significantly lower than those of children who were not underweight, $t(204) = 3.94$, $p < .001$, Cohen $d = 0.70$. The hypothesized model (with the same paths as in the previous section, but now for WAZ instead of HAZ) was also modified to take into account the non-significant path coefficient found between SES and psychomotor development (β = .02, $p = .79$). A new model without a direct path between SES and psychomotor development was then tested. The path analytic model showed a non-significant chi square fit value ($\chi^2(1, N = 204) = 0.07$, $p = .79$, $\chi^2/df = 0.07$), which supports a good fit of the predicted and observed relationships. Other statistical indices confirmed the appropriateness of the model: TLI = 1.00 and RMSEA = .00. The model indicates that SES is positively associated with weight-for-age (β = .25), which in turn is positively associated with psychomotor skills (β = .21).

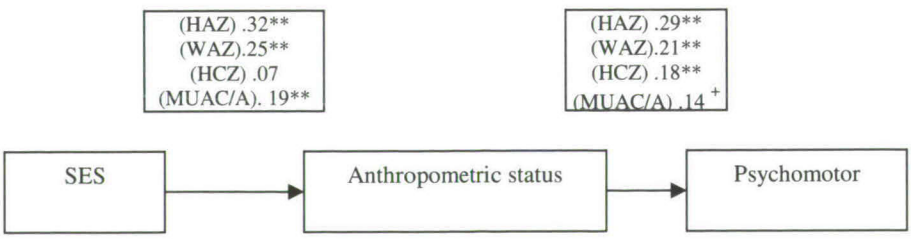
Additionally, the same model as specified above was fitted with maternal education as the SES indicator. Similar patterns as the ones seen with wealth index, emerged with the path coefficient between maternal education and psychomotor development being insignificant (β = 0.04, $p = .58$). The model was modified to remove the nonsignificant path. The modified path analytic model showed a non-significant chi square fit value ($\chi^2(1, N = 204) = .31$, $p = .58$, $\chi^2/df = .31$), which points to an excellent fit of the predicted and observed relationships. Other fit indices were excellent (TLI = 1.00 and RMSEA =.00) suggesting a good

fit of the data to the hypothesized model. The model indicates that maternal education is positively associated with height (standardized β = .24), which in turn is positively associated with psychomotor skills (β = .21).

The relationship between SES, Head-Circumference-for-Age and Performance

The psychomotor scores of children who had poor head growth were significantly lower than those of children who had normal head growth, $t(204)$ = 3.91, $p < .001$, d = 1.02. The chi square fit value of the model was non-significant ($\chi^2(1, N = 204) = 0.08$, p = .77, $\chi^2/df = 0.08$), which points to a good fit. However, unlike the model for height-for-age and weight-for-age, this model indicates that SES has a non-significant association with head circumference (β = .07, p = .76), although the latter is positively associated with psychomotor skills (β =.18, $p <$ .01). A similar pattern of results was observed when the SES indicator was maternal education. The path between maternal education and outcome was not significant (β =.09, p = .30). The model without a path from SES to outcome had an excellent fit ($\chi^2(1, N = 204) = 1.07$, p = .30, $\chi^2/df = 1.07$). The path from maternal education to head circumference was not significant (β =.09, p = .24), although the latter is positively associated with psychomotor skills (β = .18, $p <$ .01).

Figure 2. *Intervening role of anthropometric status on the relation between socioeconomic status (SES- wealth index) and psychomotor development (standardized path coefficients)*



HAZ: Height-for-age. WAZ: Weight-for-age. HCZ: Head circumference-for-age
MUAC/A*: Mid upper arm circumference-for-age. **p < .001. +p = 0.051*

The relationship between SES, MUAC -for- age and Performance

The psychomotor scores of children who had poor MUAC-for-age were significantly lower than those of children who had normal MUAC-for-age, $t(204)$ = -3.40, $p < .001$, d = 0.72. The chi square fit value of the model was non-significant (χ^2 (1, N = 204) = 0.01, p = .91, $\chi^2/df = 0.01$), which points to a good fit. However, unlike the model for height-for-age, weight-for-age and head circumference, this model indicates that MUAC/A had marginally significant

association with (β = .14, p = .051) psychomotor development. Although MUAC/A is strongly associated with SES (β = .19, $p < .001$). A similar pattern of results was observed when the SES indicator was maternal education. The model without a path from maternal education to outcome had an excellent fit (χ^2 (1, N = 204) = 0.82, p = .37, χ^2/df = 0.81). The path between maternal education and outcome was significant (β = .18, $p < .01$) although MUAC/A had marginally significant association with psychomotor development (β = .14, p = .051).

Table 5. *Summary of regression co-efficient and fit indices of the models presented*

	β *(SES-Anthropometry)*	β *(Anthropometry - outcome)*	$\chi 2$	df	p	TLI[a]	RMSEA
HAZ							
Wealth Index	.32	.29	0.96	1	.32	1.00	.00
Maternal Education	.29	.29	0.01	1	.97	1.00	.02
WAZ							
Wealth Index	.25	.21	0.07	1	.79	1.00	.00
Maternal Education	.24	.21	0.31	1	.58	1.00	.00
HCZ							
Wealth Index	.07	.18	0.08	1	.77	1.00	.00
Maternal Education	.09	.18	1.07	1	.30	0.96	.02
MUAC/A							
Wealth Index	.19	.14	0.01	1	.91	1.00	.00
Maternal Education	.18	.14	0.82	1	.37	1.00	.00

N/B: HAZ- Height-for-age, WAZ- Weight-for-age, HCZ- Head circumference-for-age MUAC/A- Mid-upper arm circumference for-age. TLI- Tuckler Lewis Index, RMSEA- Root Mean Square of Approximation

[a] All TLI values above 1 were reported as a fixed value of 1.

Discussion

Consistent with previous studies we found a relationship between SES indicators and HAZ, WAZ and MAUC-for-Age (Ayaya, Esamai, Rotich, & Olwambula, 2004; Thuita, Mwadime, & Wang'ombe, 2005). We also found that anthropometric status was significantly correlated with psychomotor performance which is consistent with earlier reports (Grantham-McGregor, 1984, 1995, 2002). The psychomotor performance of children experiencing poor physical growth ranged from moderate delay for stunting , being underweight and low MUAC-for age, to severe delay for those with poor head growth, as indicated by the Cohen's d value. These results indicate that poor head growth results in significant developmental delays that may lead to impairment and warrant intervention measures. The results are consistent with those from other parts of Africa. For instance Wolf (1999), working in Zimbabwe reports that infants with an acquired microcephaly had a high probability of developing neurological impairments by their first birthday. On the other hand, the effects of stunting, being underweight and poor mid-upper arm circumference are much more subtle; yet ignoring this is

potentially devastating at the community level due to the cumulative loss in human potential in a significant percentage of the population.

The pattern of relations between SES indicators (wealth index and maternal education) and psychomotor functioning indicates that anthropometric status fully mediated the influence of SES on developmental outcome. SES had a significant effect on psychomotor development through its influence on three intervening variables (HAZ, WAZ and Mid-upper arm circumference-for-age). The observed relationship can be interpreted within the framework of a bio-ecological perspective (Bronfenbrenner, 1979). This theoretical framework holds that a child grows up in layered environments, ranging from proximal factors (in our case anthropometric status) to distal factors (SES). Distal factors define the context for proximal factors (e. g., SES impacts on anthropometric status); proximal factors have more impact on developmental outcome than have distal factors (e. g., anthropometric status has stronger association with psychomotor development compared to SES). This emphasizes the need to investigate and interpret influences on child well-being using a multi-level approach.

Head circumference-for-age did not show the same pattern of a significant relationship with SES as HAZ, WAZ and mid-upper arm circumference. The lack of relationship between head circumference-for-age and SES might be explained by the relatively larger contribution to variance in head size of genetic factors, as evidenced by the strong association between parent and child measurements (Ivanovic et al., 2004). The association may mean that head circumference is the anthropometric measure that is less susceptible to influences of social and economic factors than other anthropometric measures. Also, we cannot exclude that some of these children have had perinatal insults, since recall of perinatal events is poor in this community (Mung'ala Odera & Newton, 2001).

In our population, we found a high prevalence of retarded growth among toddlers, especially in the rural subgroup. Furthermore, the mean scores of all anthropometric measures were below those of the reference data. Both these results are consistent with earlier studies in Kenya (Bloss, Wainaina, & Bailey, 2004; Sigman et al., 1989). This high prevalence of growth restriction and a mean score below the reference group is a potential indicator that the multiple risks experienced by children from the lower socioeconomic strata in Kenya may lead to a general suboptimal growth in this population. There is a need to pay more attention to antecedents and consequences of poor physical growth in resource-limited settings.

The importance of monitoring growth in an infant population lies in the observed adverse impact of poor growth on psychomotor development. Additionally, early psychomotor development is a building block for later skill development. In the first two years of life, children acquire knowledge and skills through sensori-motor exploration of their environment. Problems in psychomotor development in the early years can negatively impact on other aspects of child

development since motor skills support maturity in other areas such as social and communication skills (Giagazoglou et al., 2005). In fact earlier studies with undernourished children indicate that the effects of undernutrition on locomotor development is the main pathway to other developmental deficits (Gardner, Grantham-McGregor, Himes, & Chang, 1999).

Earlier studies had reported the existence of a significant association between anthropometry, socioeconomic status and developmental outcome. More recently, Walka and Pollit (2002) working in Indonesia presented a preliminary model for studying the relationship between the three variables. We extend their model and showed that the relationship between SES and outcome is fully mediated by WAZ and HAZ. The full mediation may rule out the existence of a direct relationship between SES and outcome (Strout & Bolger, 2002) which may explain some of the earlier results from Africa that reported an absence of relationship between most of the SES indicators and infant development (Aboud & Alemu, 1995 Sigman et al, 1989; Ritcher & Grieve,1991).

Our study has a two-fold limitation. Firstly, the cross-sectional design does not enable us to drawn conclusions about the possible dynamic age-dependent effects of physical growth. Future studies using a longitudinal design are needed to investigate this relationship further. Secondly, the model tested included only a limited range of potential antecedent variables, other distal influences such as maternal age, maternal IQ, and parenting behaviour may provide additional useful data to consider in the design of interventions, and to clarify further the role of SES in early child development. Research indicates that the negative effects of poor growth can be reversed or at least minimized through early intervention (Gardner et al., 2005; McKay, Sinesterra, McKay, Gomez, & Lloreda, 1978; Pollitt, Watkins, & Husaini, 1997; Powell, Baker-Henningham, Walker, Gernay, & Grantham-McGregor, 2004). As illustrated from our data it is clear that growth restriction among children living in poverty is a result of a complex chain of causation. While intervention may therefore be most effective if it is multifaceted, our study suggests that in resource-limited contexts, interventions aimed at facilitating physical growth in an underweight and stunted child population will potentially have a significant effect on psychomotor development.

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CHAPTER 3.2

THE INFLUENCE OF ANTHROPOMETRIC STATUS, ILL-HEALTH AND MATERNAL EDUCATION ON THE ACHIEVEMENT OF DEVELOPMENTAL MILESTONES IN KILIFI, KENYA*

Abstract

The aim of the study was to investigate potential markers of risk status that could be easily monitored in resource-limited settings to identify children at high risk of poor developmental outcome. A total of 85 (46 girls) children aged between 2-10 months at recruitment, were involved in a ten-month longitudinal study that took place in Kilifi, Kenya. A locally developed and validated checklist was administered to the parents to document developmental achievements every month. We tested for the influence of maternal education, being underweight, stunting and poor health on the age and rate of acquiring new developmental milestones using latent growth curve models. Stunting significantly predicted initial developmental achievements (intercepts) as well as the rates of achieving new milestones (slope). Being underweight only predicted the initial developmental status. Maternal educational level and child health were found to predict the rates at which children achieved new milestones. Being underweight, stunted, of ill-health and having a mother who lacks schooling are cost effective indicators to identify children at high risk of impaired developmental outcome within a population characterized by restricted resources.

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Children exposed to chronic poverty are at-risk of poor motor, cognitive and social-emotional development (Aber, Bennett, Conley, & Li, 1997; Korenman, Millers, & Sjaastad, 1995; Najman et al., 2004). The pathway between poverty and poor outcome is complex (Bradley & Corwyn, 2002) because the influence of poverty on developmental outcomes may be mediated by risk factors such as malnutrition, poor physical environment, unresponsive parenting, and recurring health problems (Duncan, Brooks-Gunns, & Klebanov, 1994). Given the limited resources available in most underprivileged communities there is often a need to target service provision to those children most in need. Suitable measures for identifying such children in resource-limited settings must be inexpensive, easy to measure, and predictive of developmental outcomes. This study evaluates the suitability of potential indicators that could be used to identify those children most at risk for poor developmental outcomes among children living in poverty. Using latent growth curve modelling (LGM), the current study investigates the potential role of maternal education, child health and anthropometric status in identifying children at high risk by investigating the relationship between the risk indicators and developmental achievement over a ten-month period.

Anthropometric status has been found to be predictive of mortality (Black, Morris, & Bryce, 2003), morbidity (Connolly & Kvalsvig, 1993), and poor developmental outcomes (Drewett, Wolke, Asefa, Kaba, & Tessema, 2001). It is a proxy for other biomedical risk factors such as maternal nutrition, intrauterine growth retardation, postnatal feeding and care patterns (de Onis, Monteiro, Akre, & Clugston, 1993). It is relatively easy and cheap to assess anthropometric status (de Onis & Habischt, 1996). Maternal schooling has been associated with child mortality, health and developmental outcomes although the evidence in developing countries is less consistent. It is hypothesized that educated mothers use more effective childrearing practices, more frequently use enhanced treatment and preventive services, and are more likely to contribute to household income (Desai & Aka, 1998). In our study, child health is a variable based on reported frequency of ill-health and the accompanying symptoms. This variable is included to provide an additional measure of biomedical risk. Earlier studies in another region of Kenya had indicated that the reported incidence of ill-health predicted cognitive and psychological outcomes (Neumann, McDonald, Sigman, & Bwibo, 1992; Neumann, McDonald, Sigman, Bwibo, & Marquardt, 1991). The value of this particular indicator not only lies in the ease with which it can be monitored over regular visits to the antenatal child health clinics but also in the fact that the assessment of ill-health encourages the mother to become actively involved in monitoring the symptoms of ill-health of the child.

The study aimed at looking at the potential usefulness of each of these indicators to uniquely contribute to the prediction of developmental outcomes. To achieve our goal we set out to test a model (see Figure 1) which states that

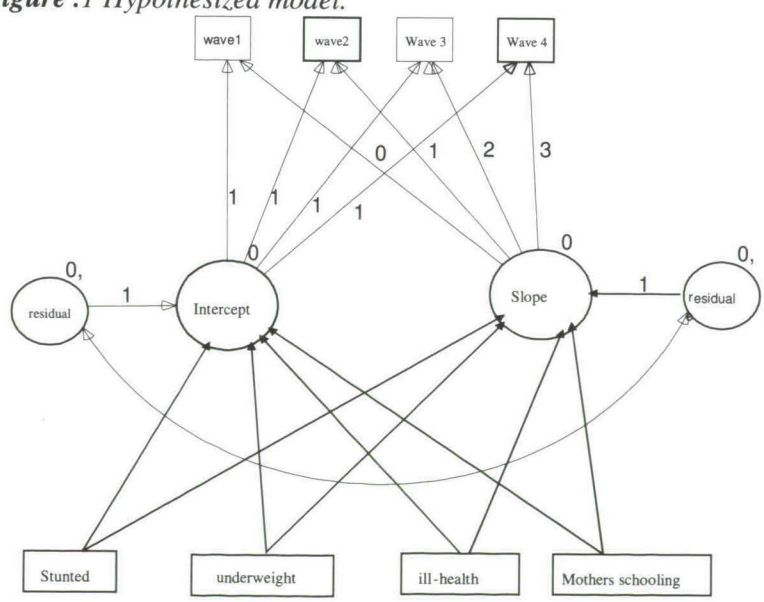
maternal schooling (i.e., schooled vs. unschooled), child health and anthropometric characteristics have independent and combined effects on both the age of reaching developmental milestones (intercept) and the rate of at which new skills are achieved (slope). More specifically, we test the hypotheses that maternal lack of schooling, child ill-health, stunting and being underweight will have a negative effect on the initial developmental milestones scores and the rate at which children achieve new milestones.

Method

Study Site

The study took place in Kilifi, a largely rural area at the Kenyan coast. The majority of families in Kilifi depend upon subsistence farming. Harvest yields are variable due to unreliable rainfalls, which has contributed to making Kilifi District one of the poorest in Kenya (Ministry of Planning and Development, 2001). It is estimated that 80% of the children in Kilifi are born at home, mostly under the supervision of untrained traditional birth attendants. Malnutrition is endemic in Kilifi with over 40% of children under five being undernourished (Maitland et al., 2006). The study took place within a demarcated area in Kilifi District that undergoes active, four-monthly demographic surveillance, in which the births, deaths, and movement of individuals are recorded.

Figure .1 *Hypothesized model.*



N/B: All the predictors were allowed to correlate.

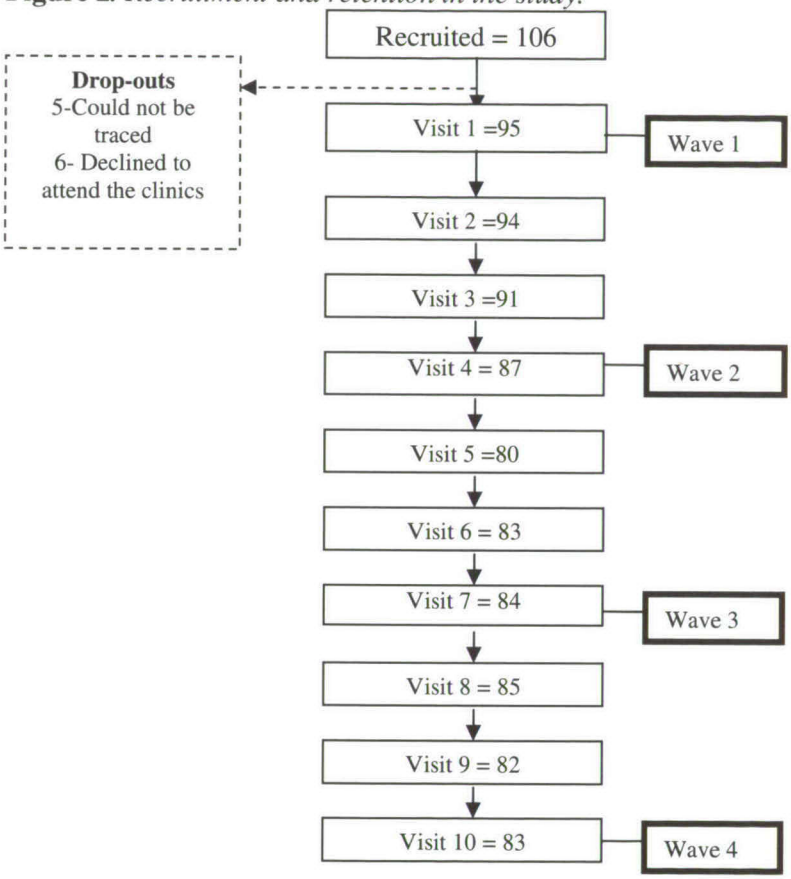
Sampling Procedures

The children were sampled to represent the population in the demarcated study area. Four government-run clinics, two in the north and two in the south of the study area, were used as focal points to recruit 70% of the sample. We randomly selected approximately 18 children from the areas within which each clinic draws its patients. The remaining 30% (N = 30) were recruited from the population attending the Mother Child Health clinic at Kilifi District Hospital, the only tertiary level government hospital in the district. Children qualified for inclusion in this study if they met the following criteria: a) aged 2 to 10 months, b) parents spoke Kiswahili or one of the Mijikenda dialects as their primary language, c) families lived within the designated study areas, and d) parent gave informed consent. A balance in gender and age (in months) was maintained in the recruitment.

Sample Description

A total of 95 (52 girls) children were initially recruited; the age range was 2-10 months. A moderate amount of attrition during the study period was found at each visit. Figure 2 presents a summary of the recruitment, retention and attrition at each time-point. The original data matrix contained 10 data points. However, the data matrix contained missing values. Furthermore, given the relative large number of time points relative to the sample size, we decided not to include all time-points, but restrict the analysis to four (first, fourth, seventh, and tenth month). A child was included in the current analysis if he or she had attended at least 5 out of the 10 visits and data were available for 3 out of the 4 data points included in the analysis. A total of 85 (46 girls) children met these inclusion criteria. The mean ages of the children (in months) for each wave were as follows [Wave 1: M = 7.20 (SD = 2.58, range 2.66-12.06); Wave 2: M =10.22 (SD = 2.60, range = 5.65-14.72); Wave 3: M = 13.42 (SD = 2.60, range = 8.80-17.70); Wave 4: M = 16.16 (SD = 2.57, range = 11.83-20.47)]. Among the children included in this analysis there were relatively few missing data (wave 1: 0%; wave 2: 3.5% (N = 3); wave 3: 2.4% (N = 2); wave 4: 3.5% (N = 3). Our analysis indicated that there were no significant differences in the age $t(95) = -0.83$, $p = .42$; gender $\chi^2(1, N = 93) = .13$, $p = .72$ and the initial developmental status $t(95) = -0.55$, $p = .58$ of children who dropped out compared to those in the final analysis.

Figure 2. *Recruitment and retention in the study.*



Measures

Developmental Milestones Form: This is an orally administered checklist that assesses motor, language and personal-social development of children aged 3-24 months. This checklist was developed in Kilifi, as part of a schema for monthly monitoring of infants at-risk. The development and psychometric properties of this checklist are reported elsewhere (Abubakar et al, submitted). Briefly, an item pool was created by reviewing the several published assessment measure such as Griffiths Mental Developmental Scale for Infants (Griffiths, 1954) and Vineland Adaptive Behavior Scale (Sparrow, Balla, & Cicchetti, 1984). All items from these measures assessing locomotor, fine motor, language and personal-social development were included. A total of 104 items were identified. These items were piloted with 63 mothers randomly selected from the community. A panel consisting of six early childhood assessors and two

psychologists discussed responses item by item and selected items based on a set criteria. Based on this process 38 items were excluded from the questionnaire. A trained community health worker completed the 66 items of the checklist in an interview with the mother. Responses were given on a three-point scale (0: not observed, 1: emergent, 2: as established behaviour). Scores from all the children attending the first visit were used to evaluate the psychometric characteristics of the Developmental Milestones Form. The measure showed an excellent internal consistency ($\alpha = .96$), high retest reliability Intra-class Correlation Coefficients (consistency coefficients = 0.94) and good age sensitivity ($r(95) = .82$, $p < .001$). Further analyses indicated that there were no significant gender differences ($t(95) = .75$, $p < .46$); consequently, gender was not included in any further analysis.

Anthropometric measures: Height was measured laying down, using a Rolla meter by the community health worker assisted by the mother. The CDC recommended protocol for taking height measurements was followed. Weights of undressed children were taken on a SECA Digital Scale. The children were weighed three times and records of weight taken when there has been a consistent results to at least one decimal point. Height –for age (HAZ) and Weight-for age (WAZ) scores were generated using the WHO 2005 software for assessing growth and development 2006 version (World Health Organization, 2005). Stunting and being underweight were defined as having a score below -2 *SD* of the WHO 2005 standards. Based on these definitions 28.2% ($N = 24$) and 20% ($N = 17$) were stunted and underweight, respectively. In this population 11.5% ($N = 13$) of the children were both stunted and underweight. The mean HAZ and WAZ were below the reference population, $M = -1.27$ ($SD = 1.52$, range: -6.11- 1.74) and $M = -1.04$ ($SD = 1.03$, range: -4.98- 1.47), respectively. No gender differences were observed in the HAZ and WAZ of the children in this population $t(85) = 0.86$, $p = .39$ and $t(85) = 1.19$, $p = .24$, respectively.

Maternal education: This measure assesses the mother's exposure to formal schooling. Mothers were asked to indicate the number of years they had attended formal education. A dichotomous schooling variable (schooled vs. unschooled) was created. Schooled was defined as having attended at least one year of formal schooling. Thirty-six percent of the mothers ($N = 31$) were unschooled. The mean years of school attendance of the schooled mothers was 5.64 ($SD = 2.53$; range: 1-12 years).

Child ill-health: This measure assesses the child's frequency and severity of poor health during the study period. Mothers gave monthly reports of their child's health. If the child had been ill, the symptoms were recorded. Based on the reported symptoms and hospital records available a consultant pediatrician graded the severity of the illness on a five point scale: 0: not ill ($N = 4$); 1: minor childhood illness ($N = 74$); 2: major childhood illness ($N = 5$); 3: chronic illness ($N = 1$); and 4: neurological disorders ($N = 1$). The frequencies of reported ill-

health and the computed severity of illness were multiplied to derive the measure labeled ill-health.

Procedure

Children were seen every month at a clinic appointment accompanied by their mothers. During these clinic visits anthropometric measures were taken alongside parental reports of the child's acquisition of developmental milestones and health in the past month. When the parent failed to attend the scheduled assessment session, the community health visitor went to the home to interview the mother to be informed about the reason for the absence and to ensure cooperation for future visits. Mothers were provided with the fare to and from the clinic. The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Written informed consent was obtained from all families and guardians of study participants.

Data Management and Analysis Strategies

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. Means were computed to derive the descriptive for each variable. Latent growth curve modelling (LGM) using Amos 5 (Arbuckle, 2003) was used to test the hypotheses stated above. LGM is considered to be a robust technique that allows for incomplete data at any time point. Growth curve models create regression type lines for each child's developmental achievements over time. Two latent factors are estimated, the first represents the child's baseline developmental status (the intercept) and the second represents the rate of change that takes place over time (the slope). To represent the child's baseline developmental status the children's intercept factors were created at a fixed loading of 1 at each wave. To represent the children's change in developmental status over time, a slope factor was created with a fixed loading of a 0 for wave 1, 1 for wave 2, 2 for wave 3 and 3 for wave 4. Additional analyses, not reported here, indicated that the inclusion of curvilinear components would not have added to the predictive power of the model. We used maximum likelihood estimation and estimates of means and intercepts since we had missing data at each wave. The fit of the overall model was evaluated using the chi-square statistic, which tests the exact fit of the model, as well as various other fit indices such as the Root Mean Square of Approximation (RMSEA), which measures the discrepancy between the predicted and observed models per degree of freedom. The ages of the children within a wave were not homogenous. These age differences were confounding variables in our design. We were only interested in defining the influence of potential risk factors and not describing the normal maturational changes. Therefore, linear regression analysis was carried out to correct for age. The standardized residuals from this analysis were used as the individual score for each child in the model.

Results

Descriptive

A steady increase was seen in the means of the developmental scores at each time-point (Wave 1: $M = 0.68$ ($SD = 0.24$); Wave 2: $M = 0.98$ ($SD = 0.24$); Wave 3: $M = 1.27$ ($SD = 0.22$); Wave 4: $M = 1.50$ ($SD = 0.16$). The data indicated that children who were stunted and those who were underweight had lower mean scores consistently across all the four waves. A mixed pattern of results was observed for children of mothers who were not schooled. Table 1 presents the means and standard deviations. In an analysis involving continuous variables; we found that HAZ, WAZ and the children's ill-health were significantly correlated to developmental achievements at each wave. However maternal education was only related to HAZ and WAZ. Table 2 presents the correlations.

Table 1. *Age Standardized Developmental Means and Standard Deviations for Stunted, Underweight and Children of Unschooled Mothers at Each Wave*

	Wave 1			Wave 2			Wave 3			Wave 4		
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*
Height-for-age												
Stunted	24	-0.68	0.92	23	-0.51	0.94	24	-0.57	1.00	23	-0.14	1.14
Normal	61	0.29	0.90	59	0.18	0.96	59	0.24	0.91	59	0.10	0.89
Weight-for-age												
Underweight	17	-0.80	0.89	17	-0.67	0.79	17	-0.76	1.12	15	-0.50	1.16
Normal Weight	68	0.22	0.92	65	0.15	0.98	66	0.20	0.87	67	0.15	0.88
Maternal education												
Unschooled	31	-0.16	0.98	31	0.05	1.06	31	-0.20	0.99	31	0.29	0.82
Schooled	54	0.12	1.01	51	0.01	0.96	52	0.13	0.96	51	-0.13	1.02

N = Number. *M* = Mean. *SD* = Standard Deviation.

Table 2. *Correlations between Key Variables in the Model*

		1	2	3	4	5	6	7
1	Wave 1	1						
2	Wave 2	.46**						
3	Wave 3	.47**	.56**					
4	Wave 4	.31**	.49**	.61**				
5	Weight-for-age	.25*	.19*	.38**	.21*			
6	Height-for-age	.38**	.25*	.44**	.24*	.69**		
7	Child ill- health	-.27**	-.20*	-.44**	-.35**	-.27**	-.27**	
8	Maternal education	.14	.01	.13	-.13	.25*	.21*	.00

*$p < .05$. **$p < .01$ level (1-tailed.)

Model with predictors

The hypothesized model showed a non-significant chi-square value $\chi^2(17, N = 85) = 17.87$, $p = .12$, $\chi^2/df = 1.49$. However, the other fit indices were below the recommended values; Tuckler Lewis Index (TLI) (.89; recommended ≥ .90),

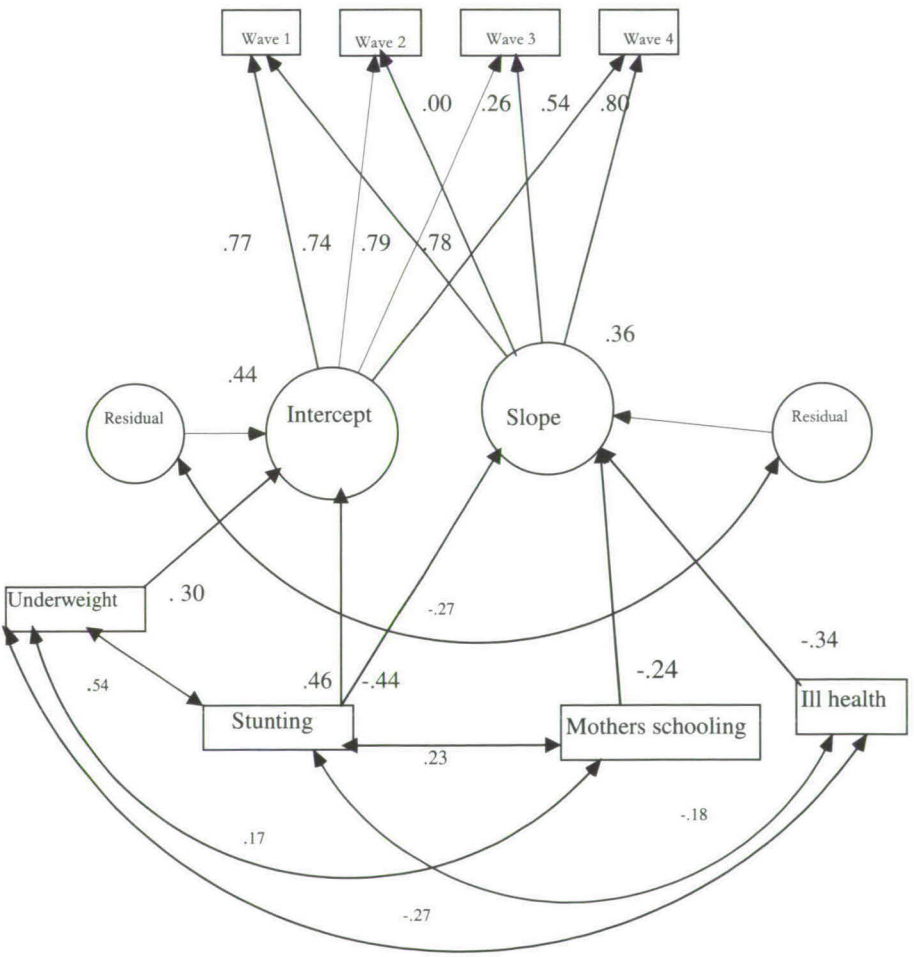
and the Root Mean Square Error of Approximation (RMSEA) (.08; recommended ≤ .06) indicating that the hypothesized model did not fit the data well. Furthermore, several paths were not significant. Specifically mother's schooling to intercept, where $\beta = .11$, $p = .36$; children's ill-health to intercept, $\beta = .19$, $p = .10$; children's ill-health to slope, $\beta = -.21$, $p = .18$ and underweight to slope, $\beta = -.01$, $p = .96$. There was therefore a need to modify the model. Since this was an exploratory model, we excluded the insignificant paths one after the other starting with the least predictive. This was carried out until we identified a model that had good fit indices and all paths were significant; see Figure 3 below. To achieve this only two of the original paths had to be excluded. The final model had a non-significant chi-square ($\chi^2(15, N = 85) = 21.20$, $p = .13$, $\chi^2/df = 1.41$), which points to a good fit of the predicted and observed relationships. Other fit indices (TLI = .91 and RMSEA =.07) also indicated a very good fit. Mothers' schooling, children's ill-health and stunting were found to predict rate (slope) of developmental achievements ($\beta = -.24$, $p = .05$, $\beta = -.34$, $p < .005$ and $\beta = -.44$, $p < .005$) respectively. Underweight and stunting predicted initial developmental status (intercept), $\beta = .30$, $p = .008$ and $\beta = .41$, $p < .000$. A look at the regression coefficients indicated that stunting had the largest effect size in terms of predicting both the slope and intercept. Both the intercept and the slope were significantly predicted by the background variables; the squared multiple correlation were .44 and .36 for the intercept and slope respectively.

We also carried out analyses, not documented here, of the same model with slightly different predictors. In that analysis maternal education, HAZ and WAZ were included as continuous variables. This model had good fit indices but the continuous variables were not predictive of slope or intercepts.

Discussion

Several observations can be made from our data set. Firstly, we observed that children who were stunted and underweight children consistently had lower mean scores at all data points. Secondly, a linear growth model provided the most adequately prediction of our dataset. Thirdly, that all the predictors included in our model influenced developmental outcomes however the pattern and magnitude of the influence varied between the variables.

Figure 4. *Model with predictors and their standardized regressions*



N/B: All Regression coefficients in the model are significant

Consistent with earlier results from both cross-sectional and longitudinal studies, stunting is found to be a salient factor in shaping child development since it predicts both the initial developmental status and the rate at which new skills are achieved (Grantham-McGregor, 2002; Grantham-McGregor, Cheung, Cueto, & International Child Development Steering Group, 2007). Thus, after accounting for maturational changes, taller children show more competent development than their smaller age-mates. In contrast, being underweight only accounted for the differences in the initial developmental status. The difference in the way the two anthropometric measures operate in this model may largely reflect their etiology. Being stunted is an indicator of chronic undernutrition, some of which may have started prenatally. Therefore its effects on developmental outcomes may be stronger compared to the effects of being underweight which reflects more short term effects of undernutrition.

We found relatively low rates of stunting and underweight compared to studies of older children within Kilifi and other resource limited settings, with reported rates of around 42% and 38% for stunting and underweight respectively (Kwena et al., 2003; Nyakeriga, Troye-Blomberg, Chemtai, Marsh, & Williams, 2004). This is consistent with earlier findings that indicate that the prevalence of poor growth outcomes become higher with age (Bloss, Wainaina, & Bailey, 2004). This underscores the need to implement intervention measures as early as possible to forestall and reverse undernutrition to reduce its impact on child health and development.

Contrary to our hypothesis, maternal education did not predict child initial developmental status (intercept). Our results on maternal education are in line with those by Sigman, Neumann, Jansen, and Bwibo,(1989) and Richter and Grieve, (1991) who did not find any influence of maternal education in cross-sectional designs.

Our patterns of results regarding maternal education lead to two conclusions. First, the cumulative negative effects of maternal lack of schooling increase with age as has been observed with other environmental variable (therefore, this variable predicts the slope). Second, these negative effects are mostly apparent through their influence on anthropometry. Our correlational analysis indicated that maternal education influenced height-for-age and weight-for-age. Based on this observation and results from an earlier study with slightly older children in this population (Abubakar et al, submitted) we hypothesize that effects of maternal education on the initial status of the child will be mediated by HAZ and WAZ. Future studies with sufficient sample size could scrutinize this hypothesis. However, given that maternal education is the only psychosocial risk factor in the model and it is not predictive of the initial status, we need to identify another factor that assesses psychosocial risk and is relatively easy to measure for inclusion in the model.

The model presented here explains up to 44% of the variance at the initial time of assessment and 36% of the variance in the rate of achieving developmental milestones. These are modest percentages, indicating that we have been able to identify some relevant indicators. However, we did not take into consideration many other maternal characteristics and biomedical factors, such as maternal anthropometric status, IQ, occupation, age, perinatal events and health history which may potentially be indicators of poor outcome. Therefore, there is a need to further study these predictors with larger samples to be able to come-up with a more complete set of simple and relatively easy to recognize indicators of children, who are likely to experience poor developmental trajectories. This would enable focused and targeted intervention programmes that maximize the use of the limited resources.

Our study has two limitations. Firstly, we had a relatively small sample size, which limited the number of time-points and predictors that could be included in the model. Secondly, our follow-up period was limited. For a more complete picture of the influences of the predictors it would have been preferable that we followed the children for a longer period of time preferably up to their second year. Therefore future efforts need to focus on larger studies with longer follow-up periods.

Based on our finding we recommend the following preliminary set of indicators predictive of poor outcome to be used for identifying children who are at high risk: stunting, being underweight, frequencies and severity of ill-health and maternal lack of schooling. Based on these results we provide two sets of recommendation a) that children who are stunted should start on an early intervention programme and b) that children who experience more than one of the other risk factors be monitored and interventions instituted in the case where delay is observed.

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CHAPTER FOUR

HIV and Outcome

CHAPTER 4.1

PAEDIATRIC HIV AND NEURODEVELOPMENT IN SUB-SAHARAN AFRICA: A SYSTEMATIC REVIEW*

Abstract

To determine the degree of motor, mental, language and social-emotional impairment related to HIV infection in the paediatric population in sub-Saharan Africa (SSA). Literature searches using MEDLINE and PsycINFO were used to identify studies. Additionally, the reference lists of previous reviews were checked to ensure that all eligible studies were identified. Cohen's *d,* a measure of effect size, was computed to estimate the level of impairment. Six published reports meet the inclusion criteria. In infancy a consistent delay in motor development was observed with a Cohen's d = 0.97 at 18 months, indicating a severe degree of impairment. Mental development showed a moderately severe delay at 18 months, with a median value d= 0.67 respectively. Language delay was not apparent until 24 months of age, d = 0.91. In older subjects, the results were not consistent, with one study reporting no negative effects on developmental and cognitive outcomes. Although HIV affects all domains of child functioning, motor development is the most apparent in term of severity, early onset, and persistence across the age groups. However, motor development is the only domain consistently assessed across all the studies. Some functional domains such as language development have not been vigorously evaluated in the SSA context; hence, the true degree of the effect cannot be adequately quantified yet.

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* Abubakar, A., Van Baar, A. Van de Vijver, F. J. R., Holding, P., &, Newton, C. (2007). Paediatric HIV and Neurodevelopment in Sub-Saharan Africa: A Systematic Review. (Revisions to be submitted: Tropical Medicine and International Health).

Approximately 80% of all HIV-1 positive children in the world live in sub-Saharan Africa (SSA) (UNAIDS, 2006). The effect on mortality has been established, but the effect on the morbidity and neurodevelopment is not clear. Vertical transmission is the main mode of infection among young children (Wiktor, Ekpini & Nduati, 1997). The mother-to-child transmission (MTCT) can occur *in utero*, at birth or through breast-feeding. Most HIV-1 infections in African children are acquired through breast-feeding (10-20% of vertically infected children), with a further 10-20% being infected at birth and less than 10% infections are acquired during pregnancy (Dabis & Ekpini, 2002). Thus the cumulative rates of transmission from the mother are 25-40%, with at least 40% attributed to breast-feeding during the postnatal period.

In the previous decades the prognosis for these children has been very poor with at least half dying before their second birthday (Newell et al., 2004). Poorly resourced and inaccessible health systems (Furber, Hodgson, Desclaux, & Mukasa, 2004; Grant & De Cock, 2001) have largely contributed to high mortality rates among HIV-infected children in SSA. Recent advances in the provision of Highly Active Antiretroviral Treatment (HAART) is likely to decrease mortality rates, as has been observed in other parts of the world (de Mortino, Tovo, & Balducci, 2000; Gortmaker, Hughes, & Cervia., 2001; Wong, Chan, & Lee, 2004).

With the anticipated decrease in childhood mortality, the impact of HIV-associated disability will become increasingly important to practitioners and policy makers (World Health Organisation, 2005). This paper presents a systematic and critical review of neurodevelopmental impairments associated with vertical HIV infection in children in SSA. The aim is to estimate the magnitude of the effect. Estimating the magnitude of this effect allows appropriate planning and integration of the special needs of children infected with HIV. We focus on SSA-based studies because the constellation of risks (notably co-infections, undernutrition, and an underdeveloped support system) in this region is different from other regions of the world (Grant & De Cock, 2001), and this may modify the outcome of vertical HIV infection (Drotar et al., 1999). For instance, co-infection of malaria and HIV at pregnancy is associated with an increased risk of poor birth outcomes (Ter Kuile et al., 2004) such as prematurity and low-birth weight, both of which are known risk factors for poor developmental outcomes (Hack et al., 2002; Picard, Dotto, & Breslau, 2000).

We set out to answer the following questions with an extensive search of the literature:

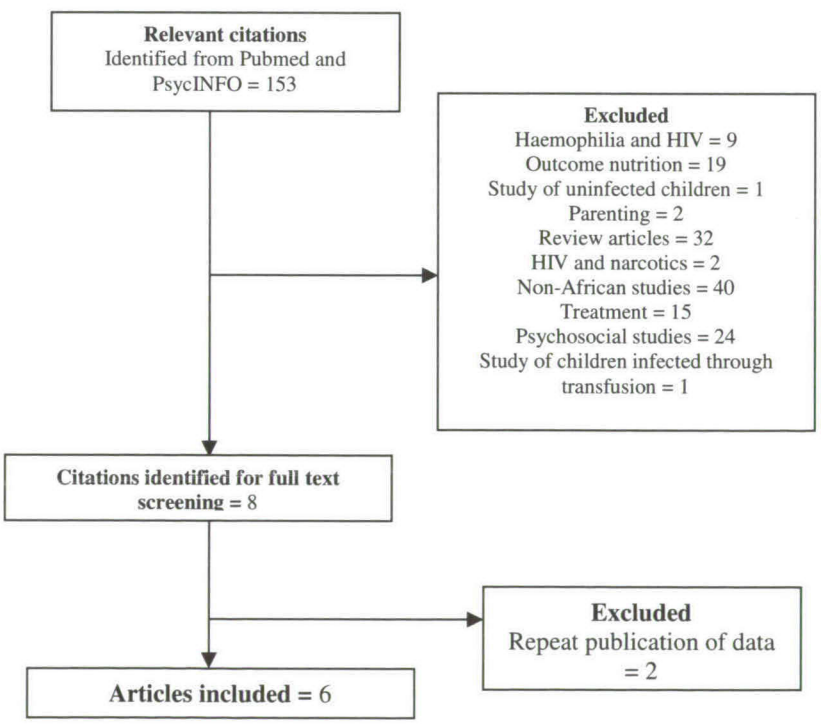
- What is the degree of motor, cognitive, language and social–emotional impairment related to paediatric HIV in SSA?
- Which domains of functioning are most affected?
- What are the known risk factors?

Method

Data Source and Search Strategy

Literature searches were carried out using two databases: MEDLINE (1980-Dec 2006) and PsycINFO (1887-Dec 2006). Additionally, we used the ancestry method (i. e., using the references cited in identified articles) to identify other articles; especially references from previous reviews on HIV and child developmental outcomes. We administered a combined text word and MESH or subject heading to identify relevant papers. The search terms included a combination of 'HIV infection', 'Child development', 'Neurobehavioral manifestations', 'Neurodevelopmental outcomes', 'Developmental impairments', 'Cognitive impairments', 'Language impairments', and 'Motor impairments'.

Figure 1: *Flowchart of the study selection*



Study Selection

The online abstracts of studies identified from the database search were reviewed and prints of potentially eligible studies obtained. All reports were reviewed by the first author. Studies were included if they met the following criteria:

- Conducted in SSA;
- HIV infection was the risk factor being studied;
- Study population must be vertically infected children younger than 15 years;
- The sample used controls for comparison or used a psychological tool standardized in the study population.
- A psychological/developmental variable was the main outcome measure.

Data extraction

Data were extracted from the original sources by two of the authors (AA and CN) independently. We used the following classification: children were considered "infected" if they had positive HIV antibody test older than 18 months or a polymerase chain reaction (PCR) test if they were younger than 18 months, and "uninfected" if they were negative. They were considered exposed if they were born to HIV-positive mothers but tested negative. Children were classified unexposed if they were born to a HIV-negative mother.

Magnitude of impairment

Given the small sample size a full meta-analysis was not appropriate. Therefore Cohen's *d,* the standardized difference between two means, was computed. This allows for the estimation of the magnitude of impairment. Conclusions on the degree of impairment can be based on values of Cohen's *d*; the cut-off values of small, moderate, and severe levels of impairments are 0.20, 0.50, and 0.80 (Cohen, 1988).

Results

Description of the search results

A total of 14 studies on HIV and child development from SSA were identified. After initial reviews of the abstract, six articles were excluded. Five of the articles were excluded because a psychological variable was not the outcome measure. The outcome measures in these studies were: nutritional deficiency (n = 3), treatment efficacy (n = 1), and child well-being (n = 1). One article was excluded because it was a review article. Thus eight potentially eligible studies were identified. After a review of the full text, two publications were excluded since their data were already included in other publications. After the abstracts were reviewed six full-text articles were identified for further analysis.

Overview of SSA-based studies

Table 1 presents a summary of the characteristics of the studies from SSA. The first study was conducted in Rwanda (Msellati, Lepage, Hitmana et al., 1993). The study assessed gross motor, fine motor, social-emotional, and language development using "a simple, reproducible measure consisting of 15 items" (pg. 844). The measure was developed by the research team after reviewing relevant developmental tools such as the abbreviated Denver Score (Frankenburg, Fandal, Sciarillo, & Burfess, 1981) and Illingworth's measure (Illingworth, 1975). Neurological abnormality was based on a physician's judgment on whether or not there were any signs of encephalopathy. The second study was from the Democratic Republic of Congo (DRC), formerly Zaire, conducted by Boivin, Green et al., (1995). The Denver Developmental Screening Test (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992) was administered to infants; this measure assesses gross motor, fine motor, language and personal-social development. In the older population Boivin and colleagues applied a translation of the Kaufman-Assessment Battery for Children (K-ABC) (Kaufman & Kaufman, 1983) which is a detailed assessment of Intelligence and the Early Childhood Screening Profile (ECSP) (Harrison et al., 1990), which is a much briefer measure intended to identify children in need of further evaluation. The Early Childhood Screening Profile screens for delays in three domains: motor, language and cognition.

Drotar et al., (1997) studied effects of HIV infection in Uganda. An adapted version of the Bayley's Scale of Infant Development (BSID) (Bayley, 1993), a measure of psychomotor and mental development, was administered alongside the Fagan Test of Infant Intelligence (FTII) a measure of information procession (Fagan & Detterman, 1992), and an adapted version of the Home Observation of Measurement of the Environment (HOME) (Caldwell & Bradley, 2001), a measure of quality of stimulation in the home. A neurological exam based on Amiel-Tison scoring system (Amiel-Tison, 1979) was also administered. In a study involving a subset of children from Drotar's studies, Peterson and colleagues (Peterson, Drotar, Olness, Guay, & Kiziri-Mayengo, 2001) investigated the effects of maternal and child HIV-infection on security of attachment. The Global Dimensions Rating Scales (GDRS), a measure of mother–infant interaction and the Attachment Q-set (Waters & Dean, 1985), were also administered. Several years later, Bagenda *et al.*, (2006) undertook a long-term follow-up of children from Drotar *et al.*'s cohort when they were at school-age. A battery of tests including the K-ABC, Wide Range Achievement Test–Third Edition (WRAT-3), which is a measure of reading, spelling and arithmetic achievement, and a neurological exam were administered. The most recent report comes from Tanzania (McGrath et al., 2006). The focus of the study was the effect of timing of mother-to-child transmission on neurodevelopment. An adapted version of the BSID was administered in this study.

Table 1. *Overview of studies from SSA*

First Author	Country of study	Number of cases	Number of controls	Age of children	Psychological measures	Study design[a]	Domains Studied
Msellati 1993	Rwanda	40 HIV+	128 Exposed 186 Unexposed	6-24 months	Measures developed by researchers	L	Fine motor Gross motor Language Socio-emotional
Boivin[1] 1995	DRC	14HIV+	20 Exposed 18 Unexposed	6-24 months	Denver Developmental Screening test	L	Fine motor Gross motor Language Socio-emotional
Boivin[1] 1995	DRC	11 HIV+	15 Exposed 15 Unexposed	3- 6 year	1. Kauffman Assessment Battery for Children. 2. Early Childhood Screening Profiles.	c-sect	Motor Cognition Language development
Drotar 1997	Uganda	59 HIV+	211 Exposed 107 Unexposed.	6-24 months	1. Bayley Scales of Mental Development. 2. Fagan Test of Infant Intelligence	L	Motor Mental Information processing
Peterson 1999	Uganda	35 HIV+	25 Unexposed	20-30 months	1. Global Dimensions Rating Scales 2. Attachment Q-set	c-sect	Socio-emotional
Bagenda 2006	Uganda	28 HIV+	42 Exposed 37 Unexposed	6-9 years	Kauffman Assessment Battery for Children	c-sect	Cognition
McGrath 2006	Tanzania	55 HIV+	221 Exposed	6-18 months	Bayley Scales of Mental Development	L	Motor Mental

[1] These studies are reported in a single publication.

a l=longitudinal, c-sect=cross-sectional

Estimates of the rates and severity of impairment

The five studies that presented means and standard deviations, were used to compute effect sizes (Bagenda et al., 2006; Boivin, Green et al., 1995; Drotar et al., 1997; Msellati, Lepage, Deo-Gratias et al., 1993). A sixth study by McGrath *et al.* (McGrath et al., 2006) reported means and confidence intervals. We used the confidence intervals reported to compute standard errors. The means and standard errors were then used to compute effect size. The infant study by Boivin *et al.* (1995) did not present means and standard deviations. However, the study presented detailed diagrams of the means and confidence intervals. This information was used to estimate means and standard error. The estimated information was then used to compute Cohen's *d.*

Neurological assessments: Two studies (Drotar et al., 1997; Msellati, Lepage, Deo-Gratias et al., 1993) investigated the prevalence of neurological abnormalities at infancy. In Rwanda the percentage of children with impaired

scores at 6 months was 15% rising to 40% by 18 months. In Uganda a much higher rate was reported; 40% of the children were impaired at 6 months of age, and 56% at 18 months. In a follow-up of long-term survivors from the Ugandan study, Bagenda *et al.* (2006) found that there were no differences in the extent of neurological impairment among the infected and uninfected children in contrast to the 2 infant studies.

Motor development: All studies that investigated motor development (Boivin, Green et al., 1995; Drotar et al., 1997; McGrath et al., 2006; Msellati, Lepage, Deo-Gratias et al., 1993) report significant differences between HIV-infected children and controls. Table 2 presents the effect size in the studies of children less than two years of age at two time points, 6 and 18 months. Results indicate that the differences in motor development were apparent as early as 6 months of age. The median effect size at 6 months is $d = 0.61$ (moderate level of impairment). By 18 months the reported median effect size $d = 0.97$ (severe degree of impairment). In the only report of motor functioning in the school-age population, Boivin *et al.* (1995) also reported a significant difference between the infected and uninfected children. The effect size in this population was $d = 1.38$ (severe level of impairment).

Mental development: In the younger population two studies (Drotar et al., 1997; McGrath et al., 2006) have investigated mental development in the HIV-infected group as measured by the BSID. The median effect size was $d = 0.39$ at 6 months, rising to $d = 0.67$ at 18 months (moderate impairment). Drotar *et al* assessed a key building block of cognition in infants: information processing using the Fagan Test of Infant Intelligence. Results indicated that there were no significant differences between the infected and uninfected children.

Table 2. *Effect sizes for different domains in studies of young children*

First Author	Year	Country	MDI at 6 months[2]	MDI at 18 months	PDI at 6 months[3]	PDI at 18 months	Language at 6 months	Language at 18 months	SE at 6 months[4]	SE at 18 months
Examples of studies from developed countries[7]										
Alywards	1992	USA		0.83		0.80				
Blanchette	2001	Canada		0.82		1.09				
Chase[8]	2000	USA	0.51	0.85	0.64	0.77				
Condini	1997	USA					sig[5]	sig		
Llorente	2003	USA		0.37		0.21				
McNeilly	1995	USA					sig	sig		
Mellins	1994	USA		0.35		0.75				
Median			0.51	0.82	0.64	0.76				
Studies in sub-Saharan Africa										
Boivin[1]	1995	DRC			2.21	1.25	n/s[6]	n/s	1.75	1.33
Drotar	1997	Uganda	0.52	0.85	0.60	1.03				
McGrath	2006	Tanzania	0.26	0.49	0.49	0.91				
Msellati[1]	1993	Rwanda			0.61	0.77	n/s	n/s	0.54	0.46
Median			*0.39*	*0.67*	*0.61*	*0.97*			*1.15*	*0.90*

1 These studies did not use the BSID (unlike the other studies reported in the table).
2 MDI: mental development index.
3 PDI: psychomotor development Index.
4 SE: Social-emotional
5 Significant difference.
6 Non-significant
7 Results of cross-sectional studies are reported as part of 18 months data.
8 Children assessed at 4 months of age

Language development: Language outcomes in HIV-infected infants in SSA have been reported in two studies of infants (Boivin, Green et al., 1995; Msellati, Lepage, Hitmana et al., 1993) and one study with pre-school children (Boivin, Green et al., 1995). In the infant studies there were no significant differences in the language scores of children at 6 and 18 months of age. However, the Rwandan study (Msellati, Lepage, Deo-Gratias et al., 1993) reported a significant effect at 24 months of age (d = 0.91, severe impairment). In the pre-school population, Boivin *et al* (1995) did not find significant language deficits.

Intellectual abilities: Two studies have evaluated general intellectual ability in children older than 2 years. Both studies applied translations of the K-ABC. They found contradictory effects. Bagenda *et al.* reported no significant difference

between HIV-positive children and controls in performance at 6-9 years of age, whereas Boivin *et al.* reported severe levels of impairments at 3-6 years of age in all aspects of functioning assessed by the K-ABC (Sequential processing: d = 2.83; simultaneous processing: d = 2.16; mental processing: d = 2.84; non-verbal skills: d = 1.55). However, with a screening device of cognitive functioning, the Early Childhood Screening Profile, no significant differences were observed between the groups in the Boivin *et al* study.

Social, emotional and behavioural development: Two studies (Boivin, Green et al., 1995; Msellati, Lepage, Hitmana et al., 1993) have examined the social development of HIV-infected children in SSA. Msellati et al reported moderate effect sizes both at 6 and 18 months while Boivin et al reported large effect sizes (see table 2). Peterson (2001) found that children who were HIV infected showed less secure attachment (d = 0.59) and less positive affect (d = 1.08).

Potential sources of variability

Contribution of social risk: Only one published study in SSA (Drotar et al., 1997) has investigated the potential contribution of social risk to outcome. This study examined whether the neurodevelopmental delays observed in the population could be attributed to mother child-interaction and the quality of stimulation provided at home. The mean scores of the HIV-positive children were similar to those of exposed and HIV-negative children. The authors concluded that the delays were independent of social stimulation at home.

Contribution of biomedical risk: In Tanzania, McGrath et al. (2006) have investigated effects of timing of infection on neurodevelopmental outcomes. In this study 11 children aged six months and identified as being early infected (defined as testing HIV positive in the first 21 days of life) had significantly lower scores in the mental scales than those identified as late infected (defined as testing HIV negative in the first 21 days of live but testing HIV positive during subsequent tests). At this early age d was 0.65. The differences between the early infected and late infected children continued to increase to a d of 1.27 by 18 months. In the motor scales, a small effect is observed at six months of age (d = 0.28). However, this effect increases to d = 1.17 by 18 months of age.

Discussion

This review demonstrates that the magnitude of impairment in motor and mental development in children infected with HIV was similar to the studies in the West despite being exposed to a more adverse environment. The effect on language development could not be assessed because of the paucity of the studies.

Patterns of results and their comparison to those from the rest of the world

Motor development in HIV-positive children was consistently and strongly delayed at all time points assessed and across all studies. This finding is consistent with results from other parts of the world despite the difference in risk factors and differences in support system (table 2). Mental development as measured by the BSID was impaired in infants. This is consistent with findings from other regions of the world. These results provide strong evidence that vertical HIV infection affects the emergence and development of sensorimotor skills.

Little is known of the effects of HIV on language functioning in SSA. In the three studies from SSA a significant language effect was only reported at 24 months of age, but not in the early months and was not found in the one study of school-age population. This is contrary to reports from the rest of the world where an impaired language development has been consistently reported (Brouwers et al., 2001; Condini et al., 1991; Coplan et al., 1998; Wolters, Brouwers, Civitello, & Moss, 1997). Coplan *et al.*, (1998) reports poorer language performance in HIV-infected children in New York. In this sample 44% of the HIV-positive children experienced language impairment, compared to 7% in the exposed but uninfected group. Additionally, Wolters *et al* (Brouwers et al., 2001; Moss, Wolters, & Brouwers, 1996; Wolters et al., 1997; Wolters, Brouwers, Moss, & Pizzo, 1995) report impairments in expressive, receptive and semantic features in four separate studies. The most plausible explanation for the results from SSA is a lack of sensitivity in the measurement tools and procedures applied. For instance, Msellati *et al* (Msellati, Lepage, Hitmana et al., 1993) administered a locally developed measure which has only three language items. Similar problems are observed with Boivin's results, which are based upon the six language items that are included in the Denver Developmental Screening Test. The use of short instruments reduces the ability of any test to detect impairment (Glascoe, Martin, & Humphrey, 1990). Further investigation of language functioning is required in SSA.

In older children diverse results were reported in the measures of cognitive abilities. Like many earlier reports, Boivin *et al.* found severe impairment to characterise the HIV-infected children, whilst Bagenda *et al.* did not report any significant level of impairment. There are several potential explanations for this discrepancy. These results could be due to specific characteristics of the sample studied, including a cohort effect as the samples differed around ten years in the years of birth. The children in these studies may have differed in biomedical factors such as viral load, CD4 count, timing of infection and disease stage that may influence neurocognitive outcomes (Smith et al., 2006). In addition, concurrent risk conditions such as malnutrition may influence neurodevelopment. Neither of the studies have presented the biomedical details of the population studied, hence the effects of these potentially confounding factors on study results

cannot be evaluated. Further more, the potentially moderating effects of psychosocial factors such as home environment, social support, and school exposure are not adequately addressed or reported. Further research with school-going HIV infected children is warranted, to allow a more detailed description of the effects of HIV in this population and hence better inform the design of intervention programmes.

The significant effect of HIV on social-emotional development is consistent with reports from elsewhere in the world (Bose, Moss, Brouwers, Pizzo, & Lorion, 1994; Jeremy et al., 2005; Moss et al., 1994; Nozyce et al., 2006). However, two major gaps in the knowledge exist in SSA. Firstly, none of the studies have presented an in-depth analysis of the social-emotional and behavioural problems presented in this population such as conduct problems, anxiety disorders, attention deficits and depression by school-age which have been reported elsewhere in the world (Mellins et al., 2003). Secondly, the SSA studies have not investigated the contribution of socio-demographic factors to social-emotional and behavioural problems observed in the paediatric HIV population. Evidence from the U. S. (Mellins et al., 2003) indicates that the behavioural and emotional problems observed among HIV-infected children were related to social and demographic risk factors and not to HIV infection *per se*. Some of the relevant factors identified include identity of caregiver (children cared for by grandmothers showed fewer conduct problems), maternal education, poverty, and gender. Further research is warranted with children from SSA.

Risk factors investigated in SSA

The social context of many children with HIV involves poverty, a lack of resources and multiple family losses (Brown & Lourie, 2000). A growing body of empirical evidence and literature indicates that biological and environmental risk factors interact to determine developmental outcomes (Sameroff & Fiese, 1990). Few studies, such as the one by Coscia, Christensen, and Henry, (1997) have investigated the relationship between familial factors, HIV and developmental outcomes. This study reports that children with the most severe neurocognitive impairment had the least stimulating environment. The report is consistent with those from other at-risk groups where it has been reported that biomedical risk interacts with the quality of home environment to either exacerbate or ameliorate the biological risk (Bradley et al., 1993). In Africa only a single study (Drotar et al., 1997) has investigated the home environment of HIV-infected children. However the study did not investigate if and how the home environment interacts with biomedical risk and contributes to the wide variability in outcome of HIV-infected children. Therefore there is a need to carry out further research to investigate the role of various home factors as potential moderators in the variability in outcome observed among HIV-infected children.

Only a single study (McGrath et al., 2006) has investigated the role of biomedical factors on variability in neurodevelopmental outcomes. The results from this study indicate that timing of infection was an important contributor to variability in outcome, the results are similar to those of the only other study which was carried out in the U. S. to investigate the role of timing of infection (Smith et al., 2000). Identification of key indicators of children at highest risk of poor outcome may potentially lead to planning targeted follow-up and maximize the utilisation of the few resources in SSA. However, there is need to study other potentially salient biomedical markers such as CD4 count, disease stage and nutritional status to fully understand the role of biomedical markers in the variability observed.

Limitations

The main limitations of the current study are twofold. Firstly, few studies could be used for computing effect sizes; therefore, our conclusions are based on a relatively small data base. Secondly, there are currently few published assessment measures of childhood outcomes standardized for Africa available; as a consequence, the quality of assessment procedures may be problematic. The studies reviewed here used different approaches to obtain the measures. One study developed a local measure (Msellati, Lepage, Deo-Gratias et al., 1993), while the rest imported measures standardised for western countries. These later studies made adjustments to content, material or scoring procedures to make the measures suitable for use in the specific context of SSA. However, the quality of the instruments in SSA was never addressed and none of the studies have reported the psychometric values of the measures after adjustment. More worrisome is the potential of the measures producing results that are difficult to interpret. For instance, there was a progressive and significant reduction in the standardised scores of the children as they grew older in one study (McGrath et al., 2006), but this may be caused by a cultural bias in the measure. Bias in measurement tools could potentially mask true levels of group differences.

Conclusion

This review indicates a need for further study of vertically infected children in SSA to describe the effect of HIV in this population in greater detail. This is especially urgent for children above the age of two, for whom so far very limited information has been documented. Based on findings from other regions of the world and also results from the adult population, we recommend that future studies administer an extensive battery of measures, assessing motor (gross and fine motor), language (expressive, receptive, semantic, pragmatic, nonverbal skills), cognition (executive functions, visuo-spatial and memory) and socio-emotional development (depression, anxiety, conduct disorders) (Pulsifer & Aylward, 1999; Rausch & Stover, 2001). This information would be useful in

planning targeted interventions to meet the special needs of the many HIV-infected children in the SSA population.

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CHAPTER 4.2
THE ROLE OF WEIGHT-FOR-AGE AND DISEASE STAGE IN THE POOR PSYCHOMOTOR OUTCOME OF HIV INFECTED CHILDREN IN KILIFI, KENYA*

Abstract

The negative effects of HIV on psychomotor development are well documented; however, a significant number of HIV infected children show levels of motor development within the normal range. Little is known of the factors that contribute to this variability in outcome. The current study aims to investigate the contribution of disease stage and weight-for-age to the variability of outcome observed in a population of rural Kenyan children. A cross-sectional design was used. A locally developed and validated measure of psychomotor development, the Kilifi Developmental Inventory was administered to 48 children (20 girls) aged 6 to 35 months, who were prenatally exposed to HIV. Of these children, 31 were infected. HIV infected children showed a significantly poorer performance than the HIV exposed but uninfected and reference samples (P=0.001). No significant differences were observed between HIV exposed but uninfected children and the reference population. Children with WHO disease stage two and three showed poorer psychomotor functioning than the reference population. Furthermore, among the HIV infected children being underweight significantly contributed to poor psychomotor functioning. Weight status and, to a somewhat lesser extent, disease stage are predictors of impaired development and hence, provide viable, easily measurable benchmarks to specify when frequent developmental monitoring and psychomotor rehabilitation are required.

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Effects of HIV on psychomotor functioning of children from sub-Saharan Africa (SSA) have been previously reported (Boivin et al., 1995; Drotar et al., 1997; McGrath, Fawzi et al., 2006; Msellati et al., 1993). These reports indicate that HIV impairs motor development and that impairments are often severe and start early. Effects of HIV on anthropometric measures (notably weight-for-age, height-for-age and head circumference) have also been reported (Berhane et al., 1997; Lepage et al., 1996). These studies indicate that vertical HIV infection resulted in an early, severe and sustained impairment in weight, height and head circumference (Berhane et al., 1997; Lepage et al., 1996). However, none of the studies in SSA have reported the relationship between growth and psychomotor development. Furthermore, no study has examined the relationship between these variables and the WHO HIV clinical staging, which reflects progression from primary HIV infection to advanced HIV/AIDS.

Documenting the relationship between psychomotor development and factors such as disease stage and weight-for-age in the HIV population in SSA is of practical significance. Variability in the motor performance of HIV infected children has been observed (Drotar et al., 1997). Given the limited resources in sub-Saharan Africa there is a need to identify the sources of these variability so as to determine risk indicators in the HIV population. Identifying simple and relatively easy to measure indicators for recognizing the children at-risk of developmental delay could ensure that this high risk group indeed receives the highest priority in care. The importance of early identification and intervention with children at risk of psychomotor impairment lies in the fact that psychomotor development is a building block for later skill advancement (Smith, 2007). In the first two years of life, children acquire knowledge and skills through sensori-motor exploration of their environment. The acquired skills support maturity in other areas such as social and communication development (Smith, 2007). Consequently problems in psychomotor development in the early years can negatively impact on later cognitive functioning and adjustment.

The aims of the present study are a) to document the effects of HIV infection and pre-natal exposure on psychomotor development using a locally developed and validated measure, b) to investigate the relationship between weight-for-age and psychomotor development, c) to investigate the relationship between disease stage and psychomotor development, and d) to examine the contribution of disease stage and anthropometric status to the variability in psychomotor outcome observed among HIV infected children and evaluate if these can be used as indicators of when to implement developmental monitoring and rehabilitation.

Methods

Study site

The study was carried out in Kilifi, a largely rural district at the Kenyan coast. Approximately two-thirds (66.8%) of the population in Kilifi lives below the poverty line (Ministry of Planning and Development, 2001). Medical facilities in the district are centered upon one district hospital. The HIV prevalence rates are estimated at 11% in the general population and 9% among pregnant women (English et al., 2003). HIV/AIDS comprehensive care that includes monthly follow-ups and treatment for any opportunistic infections and nutritional counseling is provided through a Family Health Clinic based at the district hospital. Anti-retroviral treatment was not available at the time the study was undertaken.

Participants

Children were eligible for recruitment if a) they were aged 6 to 35 months, b) parents spoke Kiswahili or one of the local Mijikenda dialects as their primary language and c) their parent gave informed consent. Three groups of children were identified, children of HIV positive mother who were themselves infected, those from HIV positive mothers who were not infected, and reference population.

Children of HIV positive mothers: The attending physician identified and approached all mothers with eligible children visiting the Family Health Clinic during the study period between September 2005 and June 2006. A total of 52 families were approached, 49 were recruited into the study, and 3 families declined. The HIV status of most of the children was not known at the time of referral, but subsequently has been determined as 32 HIV infected of these one child was excluded for not meeting the age criteria (Aged 42 months at recruitment). The remaining 17 were HIV exposed but uninfected. Laboratory criteria for the diagnosis of HIV infection for children were considered "infected" if they had a positive HIV antibody test when they were older than 18 months, or a polymerase chain reaction (PCR) test if they were younger than 18 months, and "uninfected" if these tests were negative. They were considered "exposed" if they were born to HIV-positive mothers but tested negative. Prenatal exposure to illicit drugs such as cocaine or heroine is virtually non-existent in this population.

Reference population: These children were recruited as part of a larger study to develop appropriate reference data for measures of early brain insult for use in Kilifi, Kenya (Abubakar et al. submitted). The children were recruited to form a representative sample of children in Kilifi. Children qualified for inclusion in this study if they met the following criteria: a) children reported no chronic illness in the course of the study and, b) families lived within a specified study area. We did not test for HIV status of children in the reference population due to logistical and cultural acceptability reasons. Furthermore, our estimates indicated

that very few of the children may actually be HIV positive. Based on the prevalence rates in the community (approximately 9% of pregnant mothers test HIV positive) and the expected mother-child transmission rates (25-40%) we estimated that in a population of 319 randomly selected children only 8-12 of them are likely to be HIV positive. These numbers are without correcting for the high mortality rates of up to 50 percent by the age of 2.

Measures

A locally developed and validated measure the Kilifi Developmental Inventory (Abubakar et al., 2007; Abubakar et al., submitted) was used to assess *psychomotor development.* The checklist measures two sets of skills, namely locomotor skills and eye-hand coordination. The two skills are strongly correlated so that their scores can be added in a single overall score, called psychomotor skills. An assessor interacts with the child in order to complete the activities included in the scale. Items were scored on a dichotomous scale (0: child cannot perform the task, 1: child can perform the task). In the reference population the inventory showed excellent internal consistency (α = .96), inter-observer agreement (Intraclass Correlation Coefficient = .98), test-retest reliability (Intraclass Correlation Coefficient = .96) and sensitivity to age $r(319)$ =.93, $p<.001$. Earlier studies had indicated that socioeconomic status is not directly related to performance on this scale (Abubakar et al, Submitted). Consequently this variable was not included or controlled for in the analysis.

Disease staging: The World Health Organization's (WHO) 1990 clinical staging and case definition of HIV in resource-limited settings were utilised. WHO clinical stages are categorized as Stage 1 through Stage 3, and reflect progression from primary HIV infection to advanced HIV/AIDS. Each stage is defined by specific clinical conditions or symptoms: Stage 1, HIV disease is asymptomatic with generalised lymphadenopathy. This is not characterised as AIDS and there is no functional impairment. Stage 2: unexplained chronic diarrhoea, persistent candiasis, failure to thrive, persistent fever and recurrent bacterial infections, minor mucocutaneous manifestations and recurrent upper respiratory tract infections. Stage 3: AIDS defining opportunistic infection, severe failure to thrive, progressive encephalopathy, malignancy, recurrent septicaemia and recurrent meningitis.

Procedure

Children were seen at home accompanied by their primary caregivers. Teams of two experienced assessors who were trained prior to the data collection, carried out the assessment of developmental outcome and took anthropometric measurements. One of the assessors interacted with the child to collect data on psychomotor development while a second assessor interviewed the mother to collect data on other aspects of functioning such as language development and

home environment. Two assessors took the anthropometric measures. Children were *weighed* on a SECA digital scale. Weights were taken three times and recorded within a decimal point. The assessment team was blinded to the families' HIV status. The recruitment was carried out by a different team that was not involved in the assessment. The HIV status of the children was only known to the recruitment team, not the assessors. Furthermore, children from the reference group were also seen during the same study period so as to minimize interviewer effects due to knowledge about the children's HIV status. However due to the physical conditions of some children and family members it may not always be the case that the assessors were unaware of the children's HIV status.

Data management and analysis

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. Means and frequencies were used to compute descriptive statistics. ANOVA was used to compute group differences. However for data that violated the assumption of homogeneity of variance we used Brown-Forsythe F-ratio and the Games-Howell approach to evaluate if there were any differences between groups (Field, 2005). Cohen's *d*, the standardized difference between two means, was computed to estimate the magnitude of impairment. Conclusions on the degree of impairment can be based on values of Cohen's *d*; the cut-off values of small, moderate, and severe levels of impairments are 0.20, 0.50, and 0.80 (Cohen, 1988). Weight-for-age was computed using the WHO Anthro 2005 software and reference population (World Health Organization, 2005). Being underweight was defined as having a weight-for-age score less than -2.00 in the reference population score distribution.

Ethical considerations

The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Written informed consent was obtained from all families of study participants. The consent form was read out to parents in the language with which they were most familiar. Prior to seeking individual consent, we held a series of meetings with elders and community leaders to inform them of the study aims and to obtain permission to work in their communities.

Results

Sample description

The reference sample consisted of 319 children (159 (50%) girls). The HIV exposed but uninfected group was made up of a sample of 17 children (6 girls). In the HIV infected group there were 32 children (15 girls). In the HIV infected group one child was excluded for not meeting the age criteria (42 months old at the time of assessment). The final sample consisted of 31 children (14 girls). The distribution of disease stage in the infected group was as follows: 4 were at stage

one, 21 at stage two, and 6 were at stage three. There was no significant difference in the ages of the HIV infected children, the HIV exposed and uninfected group ($F(2, 366) = 1.20$, $p < .30$). However given the known strong influence of age ($r(319)=.93$, $p<.001$) on performance we used age corrected scores in all analyses. Table 1 presents a more detailed summary of the characteristics of the children in each group.

Table 1. *Means (and Standard Deviations) of the Various Background and Outcome Variables*

Variables	Reference population	HIV exposed but Uninfected	HIV infected	*P*
Sample size per sex	160 boys, 159 girls	11 boys, 6 girls	17 boys, 14 girls	
Age	18.84 (8.43)	17.72 (8.77)	21.10 (8.86)	.300
Maternal education	3.40 (3.50)	4.35 (4.07)	4.80 (3.55)	.069
Weight-for-Age	-1.24 (1.08)	-1.28 (.79)	-2.12 (1.36)	.000
Psychomotor	0.08 (0.84)	0.11 (0.60)	-0.91 (1.86)	.001
Locomotor	0.06 (0.84)	0.27 (0.65)	-0.76 (1.98)	.050
Eye-hand	0.09 (0.90)	-0.10 (0.65)	-0.90 (1.50)	.001

Psychomotor development

Table 1 presents the means and standard deviations of the scores in each of the subscales and the total score which indicate that the scores of HIV positive children were consistently lower. Results indicated that there was a significant effect of HIV status on psychomotor scores, $F(2, 38.01) = 7.89$, $p < .001$. *Post hoc* analysis indicated that HIV infected children significantly differed from the HIV exposed but uninfected as well as from the reference population (see table 2). A similar pattern of scores was found at subscale level (Locomotor scale: $F(3, 39.19) = 5.01$, $p < .05$; Eye-hand: $F(2, 43.57) = 10.80$, $p < .001$).

Table 2. *Differences in the standardized means for different groups*

Variable	(I) STATUS	(J) STATUS	Mean Difference (I-J)
Psychomotor			
	Reference	HIV exposed uninfected	-0.02
		HIV infected	1.00*
	HIV exposed uninfected	Reference	0.02
		HIV infected	1.02*
Locomotor			
	Reference	HIV exposed uninfected	-0.21
		HIV infected	0.82
	HIV exposed uninfected	Reference	0.21
		HIV infected	1.03*
Eye-hand			
	Reference	HIV exposed uninfected	0.19
		HIV infected	1.00*
	HIV exposed uninfected	Reference	-0.19
		HIV infected	0.80*

* The mean difference is significant at the .05 level

Cohen's d was computed to estimate the degree of impairment for the children infected with HIV compared to the reference population. Results indicate that HIV infected children had severe degrees of impairment in both the psychomotor scores (Cohen's $d = 0.86$) and the sub-scales (Locomotor = 0.70 and Eye-hand = 0.84). A wide variability in the psychomotor performance of HIV infected children was found. The standard deviation for the HIV infected children was 1.86 compared to 0.84 and 0.60 among the reference group and HIV exposed but uninfected group respectively. The remarkable score heterogeneity in the HIV infected group is in line with the common finding that the group has both children with normal and impaired development. Further analyses with disease stage and WAZ were carried out to investigate their role in the observed variability.

Disease stage

Brown-Forsythe F-ratio indicated that there was a significant main effect of disease stage on psychomotor scores, $F(4, 19.17) = 4.04$, $p < .05$. *Post hoc* analysis indicates that the scores of HIV infected children at disease stage two and three were approximately 1.00 and 1.50 *SD* respectively below the reference population, although this did not reach a significant level. Further analysis indicated that there was a significant main effect of disease stage on Eye-hand scores, $F(4, 19.66) = 5.79$, $p < .01$; HIV infected children at disease stage two and

three were approximately 1.00 and 1.40 *SD* respectively below the reference. While the results for the Locomotor scores bordered on significance, $F(4, 19.91) = 2.69$, $p < .061$ with HIV infected children at disease stage two and three were approximately 0.88 and 1.40 *SD* respectively below the reference. It can be concluded that large effects were observed for all scores, although few statistical tests reached significance due to the small sample sizes.

Weight-for-Age (underweight)

A significant main effect of HIV status on Weight-for-Age Z-scores (WAZ) was observed with Brown-Forsythe $F(2, 50.60) = 8.91$, $p < .001$. *Post hoc* analysis indicates that the HIV infected children had significantly lower mean scores compared to the exposed and the reference population. We evaluated if being underweight may have differential influence on outcome within the three study groups. Among children who were exposed but uninfected only three were underweight which rendered adequate statistical testing impractical. A significant effect of being underweight on psychomotor function was observed in the reference population, $F(1, 318) = 9.85$, $p < .01$. Cohen's d indicated that the size of the effect was moderate (0.48). In the HIV infected group, there was a significant effect of WAZ on psychomotor function $F(1, 16.89) = 11.82$, $p < .03$. Cohen's d was large (1.46).

Psychomotor development, weight-for-age and disease stage

Further analysis of the relationship between these three variables was carried out in the HIV infected group. Table 3 presents the correlations between the variables and the regression coefficients which indicates that the most salient predictor of outcome in the HIV infected population is weight-for-age. Furthermore, our results indicate that in this population weight-for-age mediates the relationship between disease stage and psychomotor outcome (as correlation between disease-stage and outcome becomes weaker when weight-for–age is factored into the analysis). As can be seen from table 3 the same pattern was observed for each of the subscales.

Discussion

Our results indicate that poor anthropometric status is associated with motor impairment in HIV infected children between 6 and 35 months. Our study suggests that weight-for-age may be a salient pathway by which disease progression exerts its influence on psychomotor outcome. No significant differences were observed between HIV exposed but uninfected children and community controls; these results are consistent with those reported elsewhere (Pulsifer & Aylward, 1999). Our results provide compelling evidence to support the implementation of developmental monitoring and intervention measures

targeting the improvement of psychomotor skills within an integrated HIV care programme.

Table 3. *Regression Coefficients of the relationship between outcome measures and, weight-for-age and disease stage among HIV infected children*

	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.	Correlations	
	b	S. E	Beta			Zero-order	Partial
Psychomotor							
(Constant)	1.43	.98		1.46	.16		
Disease stage	-.22	.48	-.07	-.46	.65	-.27	-.09
Weight-for-age	.89	.20	.65	4.42	.00	.67	.64
Locomotor							
(Constant)	1.57	1.04		1.51	.14		
Disease stage	-.18	.50	-.05	-.35	.73	-.25	-.07
Weight-for-age	.92	.21	.65	4.37	.00	.66	.64
Eye-hand							
(Constant)	.98	.83		1.19	.25		
Disease stage	-.22	.40	-.09	-.57	.58	-.27	-.11
Weight-for-age	.67	.17	.60	3.93	.00	.63	.60

A large variability in outcomes of HIV infected children was observed. Our analysis indicated that, among HIV infected children part of the variability may be explained by disease stage. Children in the first disease stage one do not differ in any way from the uninfected or the reference population. However as the disease progresses, the differences become larger which is consistent with reports from the West (Nozyce et al., 1994; Smith et al., 2006).

We observed that HIV infected children had poor anthropometric outcomes which is consistent with earlier reports from Africa (Berhane et al., 1997). We extended the findings from Africa by reporting the correlation between outcome and anthropometric status which collaborates earlier findings from the West (Macmillan et al., 2001; Pollack et al., 1996). Taken together with findings from a Tanzanian study in which children of HIV positive mothers who had received vitamin supplementation performed significantly better in psychomotor tasks compared to peers whose mothers had not received the vitamin supplementation, (McGrath, Bellinger et al., 2006) our results provide strong evidence of the salient role of nutritional status in HIV related neurocognitive effects. Being underweight was an indicator of high risk of developmental impairment among the HIV infected children.

The relationship between being underweight and poor psychomotor outcome among children in resource-poor setting is not unique to the HIV

population (Kuklina, Ramakrishnan, Stein, Barnhart, & Martorell, 2004; Sigman, Neumann, Baksh, Bwibo, & McDonald, 1989). However, what is striking is the co-existence of HIV and weight problems amplifies the effects of being underweight on psychomotor development. It is relatively easy and cheap to keep track of children's weight which makes weight a useful indicator in resource-limited settings for referring HIV infected children to a psychologist for developmental monitoring and rehabilitation. The institutionalisation of measures to stop the progression of the disease and to provide nutritional support among HIV infected children should be a major public health concern. Improvement in nutrition in this population may reduce the magnitude and prevalence of motor impairment contributing to a better quality of life.

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CHAPTER FIVE

Parenting and Outcome

CHAPTER 5.1
CARING FOR INFANT-TODDLERS IN LOW INCOME COMMUNITIES AT THE KENYAN COAST: AN ADAPTATION OF THE HOME*

Abstract

The aim of this paper is to describe the adaptations made to the Infant-Toddler version of the Home Observation Measure of the Environment for use in a rural African population. A total of 425 (214 girls) children aged 6-35 months were involved in this cross-sectional study. Focus groups and in-depth individual interviews were used to generate culturally appropriate modifications. Translations and back translations of the HOME were carried out by a panel. The measure was administered at home in the presence of both mother and child. The measure lacked satisfactory internal consistency and we failed to replicate the factor structure of the published measure. However the significant correlations of a total HOME score with maternal educational levels, SES, psychomotor performance and height-for-age provides evidence for the convergent validity of the measure. Furthermore an item by item analysis identified characteristics of the home environment associated with positive developmental outcomes such as the presence of cognitively stimulating materials, maternal vocalizations, paternal involvement and sibling care giving. It is concluded that the HOME provides a useful framework for developing a culturally appropriate and valid measure of environmental stimulation for use in resource-limited settings.

* Abubakar, A., Van Baar, A., Van de Vijver, F. J.R., Obiero, E. &, Holding, P. (2007). Caring for Infant-Toddlers in Low Income Communities at the Kenyan Coast: An Adaptation of the HOME. (Manuscript being prepared for submission).

The lack of a cognitively and social-emotionally stimulating home environment has been identified as one of the four leading causes of loss of developmental potential among children in developing countries (Walker et al., 2007). Yet to the best of our knowledge no published and standardized assessment procedures have been developed to be able to assess and monitor this risk factor in sub-Saharan Africa. The current project aimed at adapting and evaluating the Infant-Toddler version of the Home Observation Measure of the Environment (HOME) (Caldwell & Bradley, 2003) for use in a rural African population.

The HOME is intended to measure the quality and quantity of stimulation and support available to a child in the home environment. It was developed to expand research beyond indirect measures of the home environment, described by socioeconomic indicators and to help understand the nature of specific environmental mechanisms that influence early behaviour and cognitive development. The focus of the information collected is the child *in* the environment, the child as a recipient of stimulating experiences (Bradley, 1994). The information needed is collected by a trained field worker; hereby referred to as a 'visitor'. The visitor obtains the information needed to complete the HOME Inventory through conversation with the parent and through observing parent-child interaction in the home environment. Several versions of the HOME exist for use with children at different ages. The current study focused on children aged 0-3 years, employing the Infant-Toddler version (IT-HOME). The IT-HOME is intended to elicit information on six aspects of child stimulation and support: responsivity, acceptance, learning material, variety, organization, and involvement (Caldwell & Bradley, 2003). The HOME inventory was selected as a framework because previous research had suggested that it is sensitive to environmental disadvantage across different cultural groups (Totsika & Sylva, 2004). Yet, psychometric studies of the HOME approach to environmental measurement reveal differences in the performance of the tool in different cultural contexts. These differences are particularly noticeable in collectivistic societies where the HOME factor structure has never been replicated (Bernstein, Harris, Long, Lida, & Hans, 2005).

The aim of this paper is to describe the adaptations made to the infant-toddler HOME Inventory for use in Kilifi District, a coastal region of Kenya. The adaptations were intended to maximize the suitability of the instrument to assess individual differences in cognitive stimulation provided by mothers in a low income and homogeneous environment. We describe the adaptation process; and report on the evaluation of the psychometric properties of the HOME measure in our context (reliability, construct and convergent validity and preliminary evaluations of predictive validity). We also use the data to identify aspects of the home environment that adequately capture the home experiences of children in

Kenya. This is significant in identifying aspects of the home environment that enhance child development in this environment.

Methods

Study Sites and Sample

The study took place at two sites. The first was the Kenya Medical Research Institute, Centre for Geographic Medicine Research (Coast), Kilifi, Kenya. Kilifi is mainly a rural community. The majority of the population in the area belongs to the Mijikenda ethnic/linguistic group. Most families in this rural community depend upon subsistence farming. Low literacy levels and high poverty levels characterize the population. Sixty-six percent of the population lives below the poverty line (Government of Kenya, 2001). Many families are polygamous, and the care of children is shared within the homestead. The biological mother may not look after children who are no longer breast-fed. As the child is weaned, increasing amounts of time are spent under the care of older siblings.

The second site was Kisauni Location, Mombasa District, which is an urban setting. This area has the second highest number of people living in poverty in Mombasa, with approximately 47% of the population living below the poverty line (Ministry of Planning and Development, 2001). Most of the poor are squatters living in informal settlements (Ministry of Planning and Development, 2001). The population consists of people from a variety of ethnic and linguistic backgrounds; Kiswahili is widely spoken as a *lingua franca*. Most families live in single-roomed household sharing most facilities with other renters. The care of children in the absence of the mother largely falls on the 'ayah' (nursemaid) or older siblings.

Adaptation Process

The development of the inventory took place in four specific stages. These were: a) construct definition; b) evaluation of the item pool; c) piloting and material preparation; and d) evaluating test applicability.

Stage 1 Definition of target constructs: All original items from the Infant-toddler HOME (Caldwell & Bradley, 2003) were initially retained in the adapted schedule of items and any exclusion was to be carried out after a more thorough evaluation. Conceptual translations were made into Kiswahili, using the descriptions of the items in the original manual to provide a guide. Kiswahili was selected because it is the most commonly spoken language in East and Central Africa. Four separate, direct rather than conceptual, back-translations into English were then prepared by members of the field staff from the research centre who were fluent in both languages. A panel consisting of child development professionals (psychologists, a paediatric nurse, and educationalists) carried out an evaluation of the back-translations, paying particular attention to potential

inconsistencies and ambiguities. This process was continued until a final draft was agreed upon. The draft was submitted to a professional translator, who evaluated the language and content for semantic clarity, and suggested appropriate modifications to the vocabulary used.

Stage 2 Evaluation of the Item pool: This process was carried out in parallel with the preparation of the Kiswahili schedule, to identify potential alternative activities and examples for inclusion in a more culturally appropriate scale. Alternative items were generated through focus group discussions, individual interviews with mothers of children aged 3-36 months and direct observations of infants and young children. The focus groups discussed local childrearing practices, to identify those considered salient by the community in shaping developmental outcomes in infancy. Material collected was compared to the content of the published HOME. Four of the focus groups were composed of mothers from the community; one of teachers, and the sixth of paediatric nurses.

In-depth individual interviews (N =10) were used to elicit additional material on child rearing practices, evaluate the acceptability of the HOME interview procedure, pilot Kiswahili translation, and evaluate the feasibility of completing the observational items. Households were selected at random from a census database kept of the study area. All the interviews were carried out outside the children's homes, as it is uncommon for visitors to sit inside a house. Parents were invited to talk about each item as it related to the target child and his/her family. Each response was rated during the course of each interview. In addition, each mother was asked to evaluate the suitability of the items to the local context.

Content analysis of the topics discussed suggested that themes raised fell into four main categories. The first category consisted of those themes common to both the HOME and to local practices. In this category the activities carried out by families may differ between contexts, but the underlying contribution to child stimulation appeared to be common to both Kenya and the USA. An example is participation in activities outside the home. The IT HOME includes items such as "child is taken to grocery store at least once a week" and "child gets out of the house at least four times a week". Local mothers talked about taking the child with her when she goes to sell things, to fetch water, to the 'shamba' (farm) or to visit relatives. The second category deals with themes that appear in both the HOME and our group discussions, but which are interpreted differently in the two contexts. An interesting example is item 12 "No more than one instance of physical punishment during the past week". The mothers of Kilifi reported that 'minimal spanking' is an essential aspect of good childrearing practices (mentioned in three out of the six groups). Characteristics of this practice are "not to spank everyday" and "not to be too harsh".

The third category included themes incorporated in published HOME but were not part of the conceptualization of good childrearing practices in our community. Several themes were identified as inappropriate for the setting or the

age group; examples of inappropriate items were dealing with books owned by young children, represented by Item 19 "At least ten books are present and visible", reading of stories to children, represented by item 42 "Parent reads story to child", as well as spanking children less than a year, and the use of tables and chairs. The final category includes themes identified in our community that were not in the HOME schedule. For instance, breastfeeding practices were identified by four out of the six groups held as important contributors to child health. Mothers' suggestions of items for inclusion fell in the main under the theme of promotion of good health. Suggestions provided included brushing teeth, cuttings of nails, washing after meals, sleeping in a clean place, and taking action when a child is ill.

Feedback from the focus groups and individual interviews suggested changes to the wording to be used on some items. For instance, item 42 "Parent reads stories to child at least three times weekly" was reworded as "Parent reads or tells stories to the child at least three times a week". We also decided to add new items, dealing with breastfeeding, cleanliness, taking action when child is ill and taking action to protect the child's health.

Our field observations suggested that the toys in this environment differed significantly from those given as examples for coding the section on availability of learning materials in the US manual. To guide the selection of replacement items we made systematic observations of the toys available to children in our community (Taylor, & Katana, 2004). Older siblings were asked to provide us with the toys their younger siblings aged 6-35 months used to play with daily. These toys were photographed. The toys were then categorised based on the function they serve. This categorisation was included in the coding sheet and training manual for the assessment team.

Stage 3 Training and piloting: A team of six field workers fluent in the local dialect and familiar with the culture was trained to administer the inventory. The team came from a diverse background (2 males with training in special education, 2 female straight from high school, 1 female with background training in early childhood and 1 female with background training in assisting with speech therapy). Training involved an introduction to concepts of child development, discussion about environmental influences on child development, instruction on interview techniques and familiarisation with the content and structure of the Kiswahili Inventory. Direct instruction on administration began with role-play sessions, and continued with practice sessions in volunteer homes. During the field based training the trainer carried out the interviews while the trainees observed and scored separately. Discrepancies were observed, discussed and resolved until consensus was reached. When the level of competence of the trainee was deemed sufficient, five interviews were held by them (without being observed by the trainer). They were then observed on the 6th interview. This process was carried out until the trainees attained at least the required 90%

agreement with the trainer as per the guidelines described in the US manual (Caldwell & Bradley, 2001). Training and piloting involved a sample of 70 children aged 6 to 35 months randomly selected from the community.

Stage 4 Evaluating test applicability: Kiswahili–IT HOME was then administered alongside a battery of child development measures in households from Kilifi and Kisauni. The Kilifi sample consisted of 320 children (161 girls) with a mean age of 18.70 months (*SD* = 8.43, range: 6-35 months). The sample from Kisauni consisted of 105 children (53 girls) sampled from the urban population. The mean age was 29.08 months (*SD* = 3.53; spread: 24-35 months).

Responses to the Kiswahili HOME were initially coded using a binary scoring procedure (yes/no), as described in the US manual and favoured by Caldwell and Bradley (2003). They advantages of the binary approach are felt to be that it has fewer interpretation differences and enables a more efficient training for the personnel. Another approach uses a Likert scale (with scores of 0, 1, and 2). In more homogeneous settings, such as the resource-limited setting of Jamaica, a Likert approach has been observed to increase the within-population variance to be found (Baker-Henningham, Powell, Walker and Grantham-McGregory, 2003).

Additional Measures

Kilifi Developmental Inventory, a locally developed measure of psychomotor functioning is administered through interacting with the child, (Abubakar et al., 2007; Abubakar et al., submitted). The checklist measures two positively correlated factors, Locomotor skills and Eye-hand coordination. The two factors can be added to provide a single overall score, labelled Psychomotor Skills.

Socioeconomic status was measured by means of two different indicators, maternal education (measured by the number of years the mother attended formal schooling) and a wealth index. This measure was adapted from the Kenya Demographic Health Survey SES measure (Central Bureau of Statistics, 2004), which lists material assets such as ownership of land and non-material assets such as maternal education (Abubakar et al, submitted). Only the 13 items from the original study that showed variation within this population and had a salient factor loading (of at least .35) on the single factor generated through principal component analysis were retained. A higher factor score indicated a higher SES. This measure is only available for children above the age of 24 months because this data were collected only in this age cohort.

Anthropometric measures Height was measured lying down using a Rollameter for children less than 24 months, and standing by a Leicester measure for older children. Two trained assistants following the CDC recommended protocol for taking height measurements administered the measures. Children were undressed and weighed on a SECA Digital Scale. The children were

weighed three times and records of the weight recorded when there was a consistent result to at least one decimal point. Weight-for-age and height-for-age standards were generated using the WHO 2005 software for assessing growth and development (World Health Organization, 2005).

Procedures

Interviews were carried out at the child's home, with the child's main caregiver in the presence of the child, in a conversational manner. The caregivers' responses were recorded during the interview (using written notes). A coding sheet was provided for each visitor. The completeness of the answers was checked on site to ensure that all items in the inventory have been covered in the interview.

Data Management and Analysis Strategies

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. Analysis focused on the selection of the more appropriate scoring procedures using the frequencies, this enabled us identify the approach likely to indicate variance in the population. The psychometric properties of the measure were then evaluated. Cronbach's alpha was used to compute internal consistency while a principal component analysis was carried out to compare the underlying the factor structure of the adapted scale to that of the original measure. The convergent validity of the tool was assessed using Pearson Product Moment Correlations between HOME scores and performance on the additional measures taken. A detailed item analysis using frequency distributions was also undertaken to investigate variability at the item level.

Ethical Issues

The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Prior to getting individual consent, we held a series of meetings with elders and leaders within the communities to inform them of the study and elicit permission and cooperation at a community level. Written informed consent was then obtained from all families and guardians of study participants. The consent form was read out to illiterate participants in the language with which they were most familiar with before signing the consent form. An article relating to the mothers articulation plus understanding of the study objectives indicated that 100% of all mothers from the urban population and 98.5% of all mothers from the rural population were articulate and were subjectively judged as having understood the study interview questions.

Results

Internal Consistency Reliability

Cronbach's alpha (based on all items) of the scale was .40 for the rural (Kilifi) sample and .58 for the urban (Kisauni) sample. Because the Kisauni sample was older, we evaluated if the differences in the values of alphas arose as a result of the rural/urban effect or because of age. The evaluation of the source of

these differences was carried out by computing the alphas of a comparable sample in age from the rural population. An evaluation of the Kilifi data indicated that for children older than 24 months the alpha was .55. This value is within the confidence interval of the Kisauni data indicating that the alphas for children aged 24-35 months in rural and urban settings do not differ significantly. Furthermore no significant differences were observed between the means scores of the urban children and the comparable rural sample (aged 24-35 months) (urban: $M = 52.07$, $SD = 5.29$; rural: $M = 50.09$, $SD = 4.\ 72$, $t(205) = -1.67$, *ns*). Based on this analysis, we decided to combine the urban and rural data for all other analyses.

Construct Validity

A factor analysis with all items including those with limited variability was carried out. This analysis indicated 17 factors with an eigenvalue larger than 1; this is in contrast to the 6 factors identified in the published HOME. Additional factor analyses indicated that we could not replicate the factor structure of the published measure. Given the impossibility to identify a clear factor structure and the aim of the inventory to measure home stimulation, we decided to opt for a one-factor solution and to compute a total score including all the items (reflecting the construct underlying the inventory). This choice enabled us to investigate the pattern of relations of the total score with outcome and antecedent factors.

Convergent Validity

Meaningful associations with antecedent factors (maternal education), and outcome (anthropometry and psychomotor development) are needed to address the convergent validity of the scale (Bradley et al., 1996; Bradley & Whiteside-Mansell, 1998). We addressed the convergent validity in different subgroups of our sample (urban vs. rural groups, younger vs. older infants). Table 1 below presents a summary of the relationship between the HOME total scores and outcome measures (psychomotor functioning and nutritional indicators) and antecedent variables (maternal education and wealth index). The analysis indicated that the home scores were sensitive to social risk, and biological risk thus providing evidence of their validity.

Table 1. *Correlation between HOME scores and antecedent and outcome variables*

Group	N	Motor	Maternal education	Wealth Index	Weight-for-age	Height-for-age	Gender
Rural	309	.16**	.20**	N/A	-.03	N/A	-.05
Urban	104	.20**	.25**	.20*	.17	.17	-.05
> 24	211	.21**	.17**	N/A	.00	N/A	-.09
< 24	202	.18**	.25**	.19**	.10	.18**	-.05

N/A – data not available

Item Analysis

Appendix 4 presents a detailed summary of our item analysis. Based on previous evidence that the spread of scores per item may change as a function of age, we present the item analysis based on three one year age-bands (0-12 months, 12-24 months, and 24-36 months). Correlations with psychomotor development, maternal education, SES and child's age are given for all items that showed variability in our population.

Considerable variability on items relating to maternal vocalization to the children and parental feeling of pride (reaction to child being praised/ or praising the child) was observed. Patterns and mode of parental responsivity were greatly influenced by the age of the child. For instance among children less than 1 year 62 % of the mothers were observed kissing or caressing them during the visit; however, this number reduced to 37% in the oldest age group. Item 12 ("No more than one instance of physical punishment during the past week") showed a significant variability in the population (see Appendix 4). The item had a significant and negative correlation with outcome ($r(422) = -.13$, $p < .01$); children that are never punished may have poorer outcome. Further analysis indicated that occurrence of physical punishment may largely depend on the child's age.

The item on the family having a pet also indicated a sizeable variability. However, most families had a 'pet animal' that had a different function but the child was allowed to be friendly to and play with the animal (e. g., dogs that were security guards for the household). Only 3.5% of the household studied kept an animal specifically as a pet for the child. Similarly, item 19 ("At least ten books are present and visible") had acceptable variability, with most families (78%) not having any book displayed while only 2.3% had ten or more books on display.

In general, items evaluating the availability of play material for the child showed acceptable levels of variability. However, only one family (0.2%) had more than one of the learning facilitators (e. g., play pen and high table), a further 8 (1.9%) had at least one of the learning facilitators while the vast majority of those in the population (98%) had none.

Among children less than 12 months of age most mothers (62%) did not talk to their children while doing the housework (item 35) but this changed considerably as children grew older; by 24-35 months of age 79% of the mothers talked to their children. Additionally we observed that most mothers (80%) went out of their way to encourage the child's development across all age groups. Despite the effort to encourage development, a large percentage (80%) did not invest in toys that encourage maturity.

We found that other members of the family and especially siblings were largely responsible for structuring the child's play and keep an eye on them when they are playing. Very few mothers (13%) actually structured their child's play. In

general almost half of the mothers kept an eye on their own child (45%); however, in the urban population this percentage was much higher (70%).

Items with limited variability

It was commonly observed that mother's speech during the visit was audible and they participated freely in the interview. All items that related to maternal speech during the visit had more than 95% of respondent scores at the maximum point. Parental hostility during the visit was rarely observed; all items assessing these aspects showed very limited variability with a mode of at least 97%. Child care is generally provided by at least three regular substitutes (91.5%). We also observed that in general the children played in environments that were safe (96.2%). However, 2.3% of children observed played in environments considered to be fatally dangerous such as roadsides. Finally, we found that both the practice of reading for children and children owning their own books were very rare in our environment. Items 42 and 45 which tapped these aspects showed limited variability at 95% and 98% scores respectively. The items in this section are those that define the general childrearing environment that most children experience in their day to day lives.

Additional Items

The item on breastfeeding was found to be heavily influenced by age. With 96.8% of all children under the age of one being breastfed while 82 % of those between 12-24 months were being breastfed. By the time children are above two years of age only 8.5% were still breastfeeding. Only 2 parents in Kilifi responded that they did not make any special arrangements to ensure there child had a good night sleep. All the other parents noted they ensured they protected their children at night by spreading out a clean sleeping place for them. In Kilifi only 20 percent of the parents noted that they placed their children under the mosquito net in addition to spreading out a clean sleeping area.

Discussion

Our results indicated a low alpha for the home measure compared to the .80-.89 reported in studies from the original datasets. This unfortunately indicates that the measure lacks adequate internal consistency within our settings. This poor reliability may result from the relative homogeneous nature of our sample which leads to a significant number of items lacking variance hence contributing to the poor alpha. This problem has also been observed with other samples which significantly differ from ours. For instance, among middle-class European families with most parents scoring well in the majority of the items, limited variance in the items has been reported, low standard deviations, poor alpha and poor discrimination between risk groups (Van Baar, 1991; Vedder, Eldering, & Bradley, 1995)

Furthermore we could not replicate the factor structure of the original HOME (Bradley, Mundfrom, Whiteside, Casey, & Barrett, 1994). This is consistent with earlier studies in other settings such as ours i. e. collectivistic communities. In a study comparing the psychometrics of the HOME in different cultural groups it was concluded that "the HOME was generally less ecologically valid with families from collectivist, interdependent cultures than with those from individualistic, independent cultures" (Bernstein et al., 2005, p. 248). This lack of validity may arise from an inadequate sampling of the child's environmental experiences and or inadequate sampling of all behaviours defining the construct. The HOME having been developed for use in a Western country focused largely on the input by the mother. However, in many collectivistic societies several other caregivers also have their input in the interaction with the child and therefore only assessing maternal contribution to stimulation does not fully capture the child's daily experiences. For instance, a study by Whaley, Sigman, Beckwith, Cohen, and Michael (2002) shows that if one assessed only maternal vocalization and visual clues then the Kenyan children in their sample seemed to receive less stimulation than a low-risk group of children in America. However, if the analysis included the vocalizations and visual clue from other caregivers in the homestead the differences between the groups disappeared.

Additionally, an inadequate sampling of the all behaviours relevant to underlying psychological processes within the context of Africa (Van de Vijver & Tanzer, 2004) may contribute to poor psychometric properties. Studies show that among African caregivers the patterns of interaction and responsivity may differ from those of the West (Kilbride & Kilbride, 1983). When responding to children's request for attention African caregivers are likely to move towards them as opposed to vocalizing which is the norm among the caregivers in the West. Therefore the items in the responsivity scale may not fully capture the construct within the African context. Future efforts in this population would focus on ethnographic work to identify other items that capture maternal stimulation currently not included in the HOME inventory.

In general the subscale on learning materials had the strongest predictive power, and more items with variation. Two potential reasons could be attributed to this. One, we carried out extensive field work to enable us to identify and effectively categorize the play material available to children in the community (Taylor & Katana, 2004). Also this scale has always been found to be more ecologically valid across the different cultural groups, compared to the subscales that attempt to define social-emotional interactions (Bernstein et al., 2005; Bradley & Corwyn, 2005). This implies that assessing opportunities for cognitive stimulation may prove easier than assessing social- emotional support available to the child at home.

Despite the problems experienced with the psychometrics of the HOME measure (i.e., a large number of items with limited variance, poor alpha and a lack

of identifiable factor structure); we observed theoretically meaningful correlations with antecedent factors such as maternal education and developmental outcomes. This is consistent with findings from Bradley's review (Bradley et al., 1996). It can be concluded that despite a lack of good psychometric properties the HOME provides a good framework to guide the development of a culture-appropriate measure of quality of psychosocial stimulation for use in resource-limited settings such as those in Africa. An interesting observation for us is that while the HOME correlated with other measures of SES, the correlation was not strong enough to invalidate the use of both. Actually our pattern of results indicate that the HOME measure should be developed to complement the indicators of SES so as to allow for a more complete description of the psychosocial risk faced by the child.

Our findings illustrate the problem that may arise when one applies the standards from one cultural or socioeconomic context to another one. For instance, our data indicates that in our environment slight spanking is associated with better rather than poorer child outcome. These findings are similar to those found among other non-Western cultures such as the Chinese where it has been observed that strict parenting which may involve spanking is protective for the children and contributes towards proper development (Chao, 1994). Future efforts in this population should concentrate on defining the construct of discipline and finding the appropriate standards, norms and their relationship to long-term outcomes such as school achievement, behavioural and emotional adjustment.

Our study indicated that siblings were actively involved in organizing and structuring the child's daily life especially those aspects that relate to play. This aspect is not assessed in the published home measure. The omission of this from the published measure is not surprising given that sibling care giving is not a very common phenomenon in Western countries (Zuckow-Goldring, 2002). However in many developing and collectivistic societies sibling care giving is common (Zuckow-Goldring, 2002), and it is widely practiced in Kilifi (Wenger, 1989). Therefore a need exists to have a subscale within a measure of the home environment in our context that assesses sibling care giving.

The items suggested by our population and included as extra items in our measure, were largely related to health issues. This mirrors the concerns that mothers face on a daily basis and relates to children's physical health. Certain items such as breast feeding showed a limited variability in the environment since there was almost universal breastfeeding for children in the infancy period ending around the age of 2. If these items are to be left in any future scale then it would have to be more specific and look at more details regarding the practice of breastfeeding itself. For instance one may need to assess when exclusive breastfeeding was stopped, or what kind of weaning habits were performed. The only item in the HOME related to health care issues is the one on 'regularity of visit to the doctor'. We observed that this item had a negative correlation to outcome especially among children older than 24 months. This observation may

largely result from the fact that mothers may take their older children to hospital only when they are ill and may not consider regular check up a necessary thing. This results taken together with the concerns and interest raised by the community on the issue indicates that there may be a need to develop a subscale that considers health care as an aspect of the home environment.

Limitations

The current study has a two-fold limitation. The first one relates to our urban sample. This sample involved only 24-35 months and did not cover the whole possible range of the scale. We therefore do not have data needed for the evaluation of the scale in the earlier age-range. Future studies should focus on developing this measure in the earlier age range in the urban sample. The second limitation relates to the outcome measure used. Our psychological outcome measure only assessed psychomotor development. We did not relate our results to other important childhood outcomes such as language and socio-emotional functioning both of which are known to correlate to HOME total scores and each of the subscales (Bradley, 1993; Bradley, 1994; Bradley, 1987; Elardo, Bradley, & Caldwell, 1977).

Conclusion

It is concluded that the HOME Inventory provides a frame work for developing a measure appropriate for use in developing countries, but also needs important adaptations for use in SSA.

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CHAPTER SIX

Partnering With Communities

CHAPTER 6.1
DEVELOPMENTAL MONITORING USING PARENTAL REPORTS IN A RESOURCE-LIMITED SETTING: THE CASE OF KILIFI, KENYA*

Abstract

A major limitation for early intervention in Sub-Saharan Africa is the lack of resources for identifying and monitoring at-risk infants. Parental reports of developmental achievement could potentially provide a cost-effective approach to identify at-risk infants in this setting. The aim of this study was to evaluate the validity of such reports and the acceptability of these procedures by parents. Ninety-five children, aged 2-10 months, were initially enrolled for a 10-month monitoring programme. The parental reports showed high reliability, correlated with age, and were sensitive to maturational changes and nutritional deficiencies. At the end of the monitoring period, focus group discussions were held with the participating mothers to evaluate the programme. Mothers reported that they found the procedures acceptable and beneficial. It is concluded that developmental monitoring using parental report to identify and monitor at-risk children in sub-Saharan Africa is viable.

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Many infants growing up in sub-Saharan Africa (SSA) are exposed to adverse conditions such as malnutrition, infectious diseases and poverty (Grantham-McGregor, Cheung, Cueto, & International Child Development Steering Group, 2007). Early intervention could potentially ameliorate against the negative effects of this exposure (Engel et al., 2007; Feldman, 2004). Research indicates that early intervention programmes such as psychosocial stimulation and parenting programmes have shown a consistent pattern of effectiveness by reducing the decline in intellectual development that occurs in the absence of intervention with effect sizes ranging from .50 to .75 *SD* (Guralnick, 1998). However, for an intervention to be effective, adequate identification and monitoring procedures should be available.

In most developed countries identification and monitoring of at-risk infants is an integral part of the health care system. Professionals such as child psychologists and in some cases paediatric nurses routinely administer standardized measures of the child's developmental achievements to screen for any delays. However, in SSA like many other developing regions of the world, there is a lack of appropriately experienced child health professionals to carry out these duties (Aikins & Marks, 2007). Therefore, an urgent need exists to find approaches to identify at-risk children that are cost effective, valid and acceptable for communities in resource-limited settings. The main objective of this study is to evaluate the validity and acceptability of parental developmental monitoring in such a setting. We set out to answer two questions:

1. Does parental report taken in a resource-limited setting provide a sensitive method for monitoring the adequate achievement of developmental milestones?
2. Would parents in such settings be willing to take part in a child monitoring programme?

Methods

Study Site

The project was carried out in Kilifi, Kenya. Kenya is situated in Eastern Africa, bordering the Indian Ocean. In Kilifi, the majority of families depend upon subsistence farming. Kilifi District is the second poorest in Kenya in terms of income per capita (Ministry of Planning and Development, 2001). The district is characterised by low literacy levels, high infant mortality and very high rates of malnutrition among under-fives; malaria is endemic (Ministry of Planning and Development, 2001). Among children aged 6-9 years, postnatal insults, such as birth trauma and neonatal sepsis in the first five years of life were identified as the main risk factor for the high rates of neuro-impairment in Kilifi (Mung'ala-Odera et al., 2006). The study took place within a demarcated area in Kilifi District that

undergoes active, four-monthly demographic surveillance, in which the births, deaths, and movement of individuals are recorded.

Sample and sampling procedures

Four government-run clinics, two in the northern and two in the southern study area, were used as focal points to recruit 70% of the study sample. We randomly selected approximately 18 children from the catchments areas of each of the clinics. The remaining 30% (N = 30) were recruited from the population that uses the (only) tertiary level government hospital in the district, Kilifi District Hospital. Mothers attending Antenatal Clinic were approached to participate in the study. Acquisition of participants was carried out over a period of one month. The recruitment was done in such a way that more or less equal numbers of children across both genders and all age groups (in months) were obtained. Children qualified for inclusion in this study if they met the following criteria: a) aged 2 to 10 months; b) parents spoke Kiswahili or one of the Mijikenda dialects as their primary language; c) families lived within the designated study areas; d) parent gave informed consent. At the end of the ten-month monitoring period, the 82 parents who took part in the developmental monitoring were invited to take part in a focus group discussion to evaluate the assessment sessions and procedures.

Instruments

Development and description of the parental report questionnaire The checklist, labeled the *Developmental Milestones Form*, monitors development in infants aged 3-24 months in three main domains, motor, language, and social-emotional development. An item pool was created by reviewing several published assessment measures including the Griffiths Mental Developmental Scale for Infants (Griffiths, 1954) and Vineland Adaptive Behavior Scale (Sparrow, Balla, & Cicchetti, 1984). All items from these measures assessing locomotor, fine motor, language and personal-social development were included. A total of 104 items were identified. These items were piloted with 63 mothers randomly selected from the community. A panel consisting of six early childhood assessors and two psychologists discussed responses item by item. Items were evaluated on a) clarity (any item that was ambiguous was removed); b) cultural appropriateness; c) age appropriateness; d) ease of expression and translatability into the local language.

Based on this process 38 items were excluded from the questionnaire. A preliminary reliability analysis suggested an acceptable internal consistency. Table 1 presents a description of each of the domains assessed. The checklist has a total of 66 items administered in an oral interview. The items are scored on a three-point Likert level (0: not observed, 1: emergent and 2: established behaviour).

Table 1. *Description of Subscales of the Developmental Milestones Form*

Name of subscale	Skills assessed	Items
Motor	Head control, sitting, crawling, walking, running, kicking, throwing, reaching, object manipulation, picking and writing.	28
Language	Pre-speech, gesture use, use of single words, object naming and recognition.	11
Personal-social	Reaction to others, recognition of others, self-recognition, daily living skills.	27

Additional measures

These measures were administered to allow for the validation of the Developmental Milestones Form. Firstly, *anthropometric measures* were taken. Height was measured laying down, using a Rollameter. The visitor assisted by the mother took the measures following the CDC recommended protocol for taking height. Weights of the (undressed) children were taken on a SECA Digital Scale. The children were weighed three times and records of weight were taken until consistent results were obtained to at least one decimal point. Weight-for-age and height-for-age standards were generated using the WHO 2005 software for assessing growth and development 2006 version (World Health Organization, 2005). Growth restriction was defined as having a score below -2 *SD* of the WHO 2005 standards.

Secondly, *maternal education:* Mothers were asked to indicate the number of years they had attended formal education. A dichotomous variable schooled vs. unschooled was created. Unschooled indicated the mothers who had no experience with formal schooling.

Administration procedures

The children were seen every month at a clinic appointment, accompanied by their mothers. During this visit anthropometric measures were taken and parents reported the child's acquisition of developmental milestones and his or her health in the past month. When the mother failed to come for the scheduled assessment session, she was visited at home. A trained community health worker carried out the assessments. This person had a basic educational level but no prior training in child development. The training in developmental monitoring of the health workers took two days.

This study was part of a larger study carried out to develop a reliable and culturally acceptable infant monitoring programme, containing measures sensitive to the social and biological risks faced by children in resource-limited settings. The main study was a cross-sectional study involving 423 children aged between 6-35 months. Therefore, in addition to developmental monitoring described above the children were examined with other forms of developmental assessments. In

this arm of the study, children were seen at home in the company of their mothers. During this visit two assessors evaluated the child and the mother. One assessor interacted with the child and assessed their psychomotor development using a locally developed measure, the Kilifi Developmental Inventory. The same assessor also administered an adapted version of the Symbolic Play Task (Lowe & Castello, 1976) and A-not-B task a measure of early executive functioning among others. The other assessor interviewed the mother and recorded the Home Observation for the Measurement of the Inventory (HOME) and a measure of language functioning.

At the end of the ten months monitoring period, five focus groups were held, one at each clinic. The purpose of this focus group was to give and receive feedback on all aspects of the study including the assessment measures mentioned in the previous paragraph. The main research question in relation to these groups was: (a) what were the perceived benefits and liabilities of study participation? (b) what were the factors that either facilitated or hindered participation in the study? Each focus group had a moderator, a note taker and an assistant. Sessions were audiotaped and hand-written notes were taken.

Data Management and Analysis:

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. Cronbach's alpha and Intraclass Correlation Coefficients (ICC) were used to evaluate reliability. Validity was evaluated using Pearson Product Moment Correlations and Analysis of Variance (ANOVA). Anthropometric analysis was carried out using Anthro 2005 and WHO standards (World Health Organization, 2005). A thematic framework was developed to analyse the information generated from the focus group discussions so as to evaluate the acceptability of the programme in the community.

Results

Adequacy of Parental Reports

Standards suggested by (Cicchetti, 1994) were used to evaluate our psychometric results. Estimates of *internal consistency* based on coefficient alpha ($N = 95$) are all within acceptable range (Motor: $\alpha = .91$; Personal-social: $\alpha = .87$; Language: $\alpha = .62$; Full Scale (Developmental Score): $\alpha = .94$). *Retest reliability* was estimated by computing intra-class correlation coefficients (consistency); the values again were within acceptable range (Motor: .88; Personal-social: .67; Language: .66; Developmental Score: .85).

The age sensitivity of the Developmental Milestones Form scores was investigated by examining its correlation with age. High correlations were found between age and the developmental score ($r(95) = .82$, $p < .001$), explaining approximately 67% of the variance; significant relationships were found for all

subscales (Motor $r(95) = .88$, $p < .001$; Personal-social $r(95) = .65$, $p < .001$; Language $r(95) = .57$, $p < .001$).

Scores of children who were seen at all ten time points ($N = 69$) were used to evaluate the sensitivity of the Developmental Milestones Form to *maturational changes*. Changes in scores across time were tested in a multivariate analysis of variance with time points as independent variables and the scale scores as dependent variables. The value of Wilk's Lambda indicated there was a significant change in scores over the ten-month period in all scales (Developmental score: $F(9, 60) = 199.63$, $p < .01$; Motor: $F(9, 60) = 140.88$, $p < .01$; Personal-social: $F(9, 60) = 64.06$, $p < .01$; Language: $F(9, 60) = 99.31$, $p < .01$).

Parental reports were correlated with the performance-based assessment of scores of psychomotor functioning using the Kilifi Developmental Inventory (KDI). A significant correlation was observed between the parental reports total score and the KDI scores $r(87) = .80$, $p < .001$. The strongest relationship was observed between the motor subscales in parental report and the locomotor subscale in the KDI, $r(87) = .84$, $p < .001$. Table 2 presents the correlation between the parental reports and psychomotor measures.

Table 2. *Correlations between the Psychomotor Scales and Parental Report*

	Psychomotor scores		
Parental report	Locomotor	Eye-hand	Psychomotor
Motor	.84**	.73**	.83**
Language	.63**	.60**	.64**
Personal social	.55**	.50**	.57**
Total score	.80**	.72**	.80**

**$p < .01$.

We evaluated the sensitivity of the measure to *nutritional deficiencies* by using ANOVA on age-corrected scores of stunted and children with normal height-for-age (HAZ). Age correction was carried out using a linear regression model. Results indicated that the stunted children showed a significantly poorer performance than non-stunted children, $F(1,93) = 17.58$, $p < .001$, $\eta^2 = .16$. Similar results were observed for each of the scales (Motor: $F(1, 93) = 8.99$, $p < .001$, $\eta^2 = .09$; Language: $F(1, 93) = 7.77$, $p < .05$, $\eta^2 = .07$; Personal-social: $F(1, 93) = 10.37$, $p < .001$, $\eta^2 = .10$).

A further analysis was carried out to evaluate if the measure was sensitive to the effects of being underweight. Results indicated that children who were underweight showed a significantly poorer performance than children with a normal weight, $F(1, 93) = 19.30$, $p < .001$, $\eta^2 = .17$. Similar results were observed for each of the scales (Motor: $F(1, 93) = 13.67$, $p < .001$, $\eta^2 = .13$; Language: $F(1, 93) = 6.21$, $p < .05$, $\eta^2 = .06$; Personal-social $F(1, 93) = 11.23$, $p < .001$, $\eta^2 = .11$).

An analysis of variance with age-corrected scores was conducted to evaluate the measure's sensitivity to *social risk* factors. Children of mothers who were not schooled did not differ in their developmental performance score from children of schooled mothers in all the subscales (developmental score: $F(1, 93) = 2.10, p < .15$; Motor: $F(1, 93) = 0.28, p < .60$; Language: $F(1, 93) = 0.48, p < .50$; Personal-social development $F(1, 93) = 3.36, p = .07$). However children of mothers who were not schooled were more likely to be underweight (29%) than those who were schooled (14.8%). Similarly, children of unschooled mothers were more likely to be stunted (41.9%) than those who were schooled (20.4%). Our results indicate that maternal education may affect developmental outcome through its influence on nutrition and growth.

Acceptability of developmental monitoring to parents

Approximately 93% ($N = 72$) of the invited mothers attended the focus group discussions. Four major themes of relevance to evaluating the acceptability of the programme in the community were identified which are discussed below.

Perceived benefits: In all focus groups mothers reported several perceived benefits; Table 3 presents a summary of these results. The mothers reported that they became more aware of the *need to stimulate* and encourage their child's growth and also reported that they got suggestions on toys that could be used during this process. Moreover, they reported that taking part in the programme increased *awareness of their child's developmental stages*, which enhanced their ability to actively monitor their children's achievement of developmental milestones. This knowledge was acquired by deducing information from the questions about a normal developmental trajectory of the children and discussion with the community health worker who monitored their children's growth. Furthermore, they reported to have benefited from observing performance-based assessment sessions since they got suggestions on toys and *play activities* they could use to provide further stimulation to their children.

Perceived liabilities: In all groups there was at least mention of the fact that nothing about the study was found to be annoying or potentially risky or harmful for the participating families, which suggests that participants were happy with the study design and measures. However, several aspects of the design were pointed out to be a liability (see Table 3 for a summary). The most commonly mentioned factors were the amount of time they had to spend in the clinics and the interruption of their daily schedule

Table 3. *Perceived Benefits and Liabilities in Taking Part in the Infant Monitoring Programme*

Theme	Sub-themes	Examples of supporting statement	*N*
Perceived Benefits			
	Children experienced accelerated growth	'…I suspect the items you gave my child or the activities he participated in stimulated his mental growth…'	5
	Increased awareness of the need to stimulate child development	''The important thing I learnt is that when you give birth you need to teach them different things, need to try and see if they will learn…'	4
	Actively monitored child's development	'As the months passed you know that a child must be monitored... I mean you must understand them'	4
	Increased awareness how to stimulate child development.	' .. that when the child speaks to you, then you need to respond… even if you do not understand them try to respond '	4
	Increased awareness of child's developmental stages.	'Now we know more… child can remember…. We had not monitored these despite having given birth to other children… this is not my first born, but did not know (a lot). So in my life I received an eye opener'.	4
	Encouraged to participate in play activities	'Sometimes even when not visited (team has not gone to assess the child) we try out the activities so that we can also grow mentally (improve ourselves)…..'	2
	Increased awareness of their teaching role	'… Learnt… we are like teachers....'	1
	Free medical treatment when the child was ill	'Since I had this baby, he has always had (health) problems, then you came to him, you said I bring to your clinic you try to help... I came and child is better now'	1
	Child got new and exciting experiences	'Child got a chance and got used to travelling by car to Kilifi (clinic)	1
	Learnt of child's nutritional needs	'Only learnt about food (feeding the child)'.	1
	Detailed and accurate measurement of growth	'So important for where we go (Antenatal Clinic) they do not measure head, arm or length'	1
Perceived Liabilities			
	None	'Nothing bad observed'	5
	Did not approve of some of assessment procedures	'… this idea of coming we talk and then you look around the house (observe the home environment and physical set up'.	3
	Time consuming	'May be the fact that we had to seat for many hours; sometimes one had to wait half an hour'	2
	Husband annoyed by her participation	'When you come (to the home) I got scared because I had told him (husband) I was no longer attending the clinics)	2
	Interruption of schedule	'Problem is that one has to break (disrupt) daily schedule to come to clinic'	2
	Unannounced visits i. e. visits without prior appointment	'I felt disturbed because the first time (you visited) I was not aware … (I had) gone out with daily business (I) come back and was told you were there… I was unhappy …'	1
	Fatigue in responding to the same set of questions	'The questions were too many'	1

N: Number of focus groups in which the issue was raised.

Factors encouraging participation: We also asked the mothers to indicate the factors that encouraged them to fully participate in the programme and attend each of their monthly appointments: Table 4 presents a summary of these reasons. Mothers reported that they took part for several reasons including curiosity; they were encouraged by the fact that the monthly appointments did not involve the drawing of blood; they found that the assessment procedures were better than what they experienced at the usual clinic visits; they were encouraged and even sometimes compelled by their husband; lastly, they did not want to be perceived as rude if they declined to take part. Clearly, there was a mixture of factors that led mothers to take part in the project.

Factors hindering participation: Several factors were mentioned as hindering participation in the project: Table 4 below presents a summary of these factors. The most commonly mentioned factors were coinciding with other obligations such as attending a funeral or a college, and traveling to visit relatives in another location.

Table 4. *Reasons for Participating in the Programme and for Missing Appointments*

Themes	Sub-themes	Examples of statement	*N*
Reasons for taking part			
	Attending to another obligation	'I was nursing a sick relative'	4
	Curiosity	'Just wanted to know what will happen…'	3
	Encouraged and sometimes compelled by spouse	'If it was nor for my husband I would have stopped long time... but he was so enthusiastic. That I wondered why some months you did not invite him'	2
	Voluntary participation	'…because from the very start the study was properly explained and we made decision to take part so had to continue'	1
	Attends to avoid being perceived as rude	'if I did not attend you would have thought I am rude'	1
Reasons for missing appointments			
	Forgot the dates	'had no one around to read for me the dates for the next appointment'	2
	No one to assist care for the other children	'I did not attend because I had no one to assist me'	2
	Mother or child was ill	'I missed because I was ill… even when you followed me to the house I was still having a fever'	2
	Travelling	'I had travel elsewhere at that time'	1
	Busy	'I had a lot of other things to attend to'	1
	Spousal refusal	'I did not attend because my husband told me not to attend'	1
	Notice was short	'I was given the fare so abruptly that is why you did not see me'	1

Discussion

Psychometrics

Results indicated that the monitoring form has good internal consistency and test-retest reliability. In addition, the measure strongly correlated with age and was sensitive to maturational changes by showing a progressive increase in scores across each of the months children were assessed. These results provide evidence of the reliability and validity of the measure developed (Gregory, 1992; Kline, 1993).

Consistent with earlier results of the relationship between anthropometric indicators and developmental outcomes, we found a significant effect of HAZ and WAZ on all aspects of development with the stronger effects being on motor development (Wachs, 1995; Walka & Pollitt, 2000). Maternal education was chosen as an indicator of socioeconomic status because earlier reports within this population had found it to be predictive of certain aspects of cognitive outcomes such as language functioning (Holding et al., 2004). However, we found limited relationship between maternal education and reported child achievements. This limitation may result from the differential influence of socioeconomic status at different developmental stages (Molfese, Dilalla, & Bunce, 1997). Influence of maternal education may be more apparent in later stages when language and symbolic thinking becomes more important and more time has passed in which maternal education could influence the development. Additionally, the influence of maternal education on motor outcome may be indirect through its influence on WAZ and HAZ. This speculation is based on earlier results with slightly older children where we found that WAZ and HAZ fully mediated the relationship between psychomotor performance and SES indicators including maternal education (Abubakar et al, Submitted).

Acceptability

Mothers expressed their satisfaction with the developmental monitoring, which is usually taken as an important indicator of programme successes during evaluation (Garner, Panpanich, & Logan, 2000). Perceived benefits from participating in this project seemed to be the key factors contributing to satisfaction in this population. Results indicated that the mothers most appreciated the opportunity to learn and monitor their children which is consistent with a report from a nutritional monitoring programme in South Africa (Faber, Phungula, Kvalsvig, & Benade, 2003).

Our findings indicate that involving parents in monitoring their children has the advantage of not only identifying at-risk infants but also raising parental awareness of developmental issues, which brings a potential intervention benefit by getting mothers to pay more attention to their children's developmental needs. Furthermore, our results have given a first indication that a programme to train parents would be positively received in this community.

Several factors were reported to have hindered maternal participation in the project. Most of these factors were extrinsic and not directly related to developmental assessments and procedures, such as attending another obligation. Yet, intervention-related factors were also mentioned; the most notable was the length of time spent at the clinic and the requirement to respond to the same questions at each visits. These issues must be taken into account in the planning of such a programme in order to maximize participation. For instance, to minimize the amount of time and disruption that may be caused by taking part in a programme, programme developers could try to combine sessions devoted to developmental monitoring with other heath visits to the clinic (e.g. immunization). Another option would be to develop a community–based developmental monitoring programme so that mothers do not need to travel to clinics.

The current study has several limitations. First, we do not have a specialist's opinion of the child's developmental level to compare to the level of achievement indicated by the parents. Parents have been found to over-estimate their children capabilities for several reasons including wanting to have their children appear more capable. Despite this obvious shortcoming we still recommend parental reports given that they are cost-effective and may be the most feasible approach to implement in resource-poor settings. However it is important to develop checks and procedures to validate parental reports or identify moderators of the authenticity of parental reports. Secondly, our sample size is relatively small and future efforts should involve a larger sample. Thirdly, the focus group discussions which were aimed at evaluating the programme were conducted by the study team. The moderator was the community health visitor who had worked with the mothers. This procedure may have biased the results in that the mothers may have felt the need to moderate their criticisms. Lastly, the extensive programme we used, that also included more formal developmental assessments by trained professionals, may have shaped and increased the mothers' knowledge on child development and hence affected their assessments.

Taken together, these results indicate that parental reports of child developmental milestones provide adequate information to identify at-risk children in resource-limited settings such as those in rural Africa. Future studies could follow up the cohort of children in later years to determine the predictive validity of these parental reports; and if the reports are able to distinguish clinical risk. Based on the findings of this preliminary study it can be concluded that it is possible to design a developmental monitoring programme in a resource-limited setting that is feasible and acceptable for the mothers. Parental reports on the child's achievement level provide a relatively quick and cost-effective approach to gather information for identification of potentially at-risk children.

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CHAPTER 6.2
ENHANCING THE VALIDITY OF PSYCHOLOGICAL ASSESSMENT IN SUB-SAHARAN AFRICA THROUGH PARTICIPANT CONSULTATION*

Abstract

There are few psychological tools developed and standardized for use in sub-Saharan Africa. Consulting with target populations provides a potentially powerful procedure to develop and adapt measures for this population. This review identifies and describes methods used to consult target populations in sub-Saharan Africa. Relevant studies were identified using PsycINFO and PubMed, supplemented by a review of relevant books. We further illustrate the role of participant consultation in psychological assessment with examples of our work in Kilifi (Kenya). Three major approaches are described: focus groups, individual interviews, and participant observation. Participants have been consulted to generate items, identify appropriate assessment procedures, clarify the language used, and define constructs. It is concluded that participant consultation has contributed to the enhancement of construct, content, and criterion validity of studies carried out in sub-Saharan Africa.

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* Abubakar, A., Van de Vijver, F. J. R., Van Baar, A., Wekulo, P . & Holding, P. (2007). Enhancing the Validity of Psychological Assessment in Sub-Saharan Africa through Participant Consultation (Accepted pending revisions: Book of Selected Chapters from the 18th Congress of the International Association for Cross Cultural Psychology).

In sub-Saharan Africa (SSA), like in many developing regions of the world, the lack of psychological research has significant implications for intervention and research (Mpofu, 2002). We are particularly interested here in the absence of culturally appropriate, reliable, and valid psychometric measures (Holding et al., 2004; Kathuria & Serpell, 1998). Importing standardized tests from Western countries may seem to provide the easiest solution for this shortage. However, the transfer of tests to a non-Western context is frequently accompanied by test bias and limited validity (Greenfield, 1997; Van de Vijver, 2002). This bias may be due to a lack of familiarity with test demands (Mulenga, Ahonen, & Aro, 2001), poor translation of test items (Van de Vijver, 2002), stimulus unfamiliarity (Sigman et al., 1988; Sonke, Poortinga, & de Kuijer, 1999), and incomplete coverage or poor sampling of behaviours associated with a construct (Sternberg et al., 2002; Van de Vijver & Tanzer, 2004). Two approaches, adaptation and assembly, seem to provide the most adequate solutions to the shortage of assessment measures in SSA (Malda & Van de Vijver, 2005). Adaptation involves retaining some and changing other features of a Western instrument to increase the suitability of the instrument for the new context, assembly involves the construction of a new assessment measure.

Participant consultation, through techniques such as focus group discussions, in-depth interviews and participant observations, may provide a useful means of gaining the necessary insight to carry out adequate adaptation or assembly. We define participant consultation as any procedure that uses an interactive approach with local populations to gain in-depth information of local knowledge, behaviors and beliefs with the aim of improving the validity of psychological measures, the cultural adequacy of the testing procedures, the involvement of the participants in the testing procedure, and the usefulness of the results for the participants. Participant consultation may have a role to play at different stages of test development. The value of using participant consultation in instrument development and adaptation has long been recognized and advocated for (Haynes, Richard, & Kubany, 1995), although rarely used (Vogt, King, & King, 2004). The purpose of the current paper is to identify and describe how participant consultation can and has been used to enhance the validity of psychological assessments in sub-Saharan Africa. Specifically, the current review set out to answer the following questions:

- Is participant consultation carried out in psychological studies in SSA?
- If so, which methods have been used?
- What has been the contribution of these consultations to test development?

Review Method

A search in Pubmed and PsycINFO identified articles for inclusion in the current paper. The search term "Africa" was combined with one or more of the following terms: "Psychological Research", "Psychological Assessment",

"Participatory Research", "Test Development", "Test Adaptation", "Focus Group Discussions", "Interviews", and "Observations". Approximately 440 studies were found through this search. We supplemented this with a search of relevant textbooks identified by checking references of identified works. The following criteria were applied to select studies using participant consultation from the identified studies.

1. Conducted in sub-Saharan Africa;
2. Collected empirical data;
3. Reported the development or adaptation of cognitive, neuropsychological, or developmental assessment techniques;
4. Applied psychological assessment techniques;
5. Targeted the description of the indigenous definition of a psychological construct.

We supplemented the review of relevant studies with examples from our fieldwork in predominantly rural communities in Kilifi District, Kenya. The majority of families in Kilifi depend upon subsistence farming; more than half (66.8%) of the population in the District lives below the poverty line (Government of Kenya, 2001). Most families are polygamous and live in homesteads containing several buildings. Extended families share in child rearing. After weaning most children spend time with older siblings and spend little time in a dyadic interaction with an adult. The relationships between people of different generations are regulated by cultural rules that guide all aspects of children's relationship to adults including greetings, style of communication, and patterning of spatial positions (Wenger, 1989). Systematic observations have shown us that there are almost no shop-bought play materials and most children use homemade play items, often produced by older siblings (Taylor & Katana, 2004).

Is Participant Consultation carried out in Psychological Studies in SSA?

The review identified works in SSA that have consulted with target populations. A total of 14 studies that met our inclusion criteria were identified. Table 1 presents an overview of the identified studies.

What Are the Methods Used to Consult with Participants in Africa?

Focus group discussions, individual in-depth interviews, and participant observations were identified as the approaches applied by investigators to consult with target populations. In some studies the investigators used a multi-method approach to collect their data. The next section presents a description of how each of the methods was applied, illustrated with examples taken directly from listed studies.

Focus group discussions: Patel, Simunyu, Gwanzura, Lewis, and Mann, (1997) used focus group discussions to identify and generate items for the

development of an indigenous measure of mental illness: the Shona Symptom Questionnaire. The discussions with primary caregivers of psychiatric patients (nurses, relatives, traditional healers, and community-based workers) were held to elicit idioms of mental distress. Generated items were used to develop a preliminary questionnaire which was then compared to the WHO Self-Report Questionnaire. This comparison indicated that only 9 out the 20 WHO items were similar to the locally developed items both in terms of conceptualization and wording. All the WHO items and the local items were taken through a series of piloting and item selection. The final selection of items was based on psychometric analysis and the final questionnaire (the Shona Symptom Questionnaire) included items both from the WHO questionnaire and locally derived items. The measure has good psychometric validity and sensitivity.

Mung'ala-Odera et al. (2004) initially used the translation and back translation method to produce a Kiswahili version of the Ten Questions Questionnaire (TQQ), a screening tool to identify children with neurological impairments in Kilifi, Kenya. Pilot results using the translated version of the TQQ indicated that an unexpectedly large group of children were identified as impaired. A series of focus group discussions were then held with randomly selected groups of mothers from the community to identify the sources of error. During the focus group discussions mothers' interpretations and understanding of each question in the questionnaire was discussed. The authors discovered that the mothers misunderstood the questions because the translation of some of the items to the local dialect was ambiguous. For instance, the question asking whether or not the child had a hearing impairment could also be translated to mean that the child is inattentive. The focus groups made it clear that modifications had to be made to item wording and provided new wording. The results from the adapted instrument showed prevalence rates similar to those from other developing countries. The measure also had excellent test retest and inter-rater agreement.

Holding (in preparation), in Kilifi, Kenya, identified activities for inclusion in a quality of life measure through semi-structured discussion groups with children aged 11 to 15 years. Children were requested to list enjoyable activities and those they did not enjoy. Additionally, they were asked to mention any taboos or restrictions on participation in the listed activities. The generated items were used to provide substitute items and relevant probes in the adaptation of the Childhood Asthma Questionnaire (French & Christie, 1995). In another application of focus group discussions to generate test items for a measure of infant mental development, Ogunnaike and Houser (2002) used material drawn from a series of focus groups by Aina, Agiobu-Kemmer, Etta, Zeitlin, and Setiolane (1993). The focus groups indicated that Yoruba caregivers encouraged children to identify and name items in their immediate environment. The items identified as commonly used were included in relevant sections of the Yoruba Mental Assessment Scale, a measure of mental development for infants.

Table 1. *Studies in Sub-Saharan Africa that Employed Participant Consultation*

First author and publication year	Country	Aims	Methods of consultation
Abubakar (in preparation)	Kenya	To identify items, materials and appropriate assessment procedures	Participant observations
Adejuwon (2005)	Nigeria	To generate items for a measure of adolescent behaviour	Focus group discussion
Alcock (in preparation)	Kenya	To identify and generate items for inclusion in a test of verbal knowledge.	Focus group and in-depth interviews
Bolton (2001)	Rwanda	To develop a procedure for criterion validation	In-depth interviews
Bolton (2004)	Uganda	To define the concept of depression	
Grigorenko (2001)	Kenya	To define the construct of intelligence	Semi-structured interviews and focus group
Holding (in preparation)	Kenya	To identify and generate items for a measure of quality of life	Focus group
Ice (2002)	Kenya	Item and vocabulary generation for a measure of perceived stress levels.	In-depth interviews and focus group
Kambalametore (2002)	Malawi	To define the construct of adaptive behaviour	In-depth interviews, focus group participant observation
Kitsao-Wekulo (in preparation)	Kenya	To identify and generate items for a measure of practical intelligence	Focus group
Mpofu (2002, 2004)	Zimbabwe	To define the construct of intelligence	Written interviews
Mullin (2002)	South Africa	To define that concept of quality of life	Interview
Mung'ala-Odera (2004)	Kenya	Item clarification	Focus group
Ngara (2004)	Zimbabwe	To define the construct of giftedness	Written interviews
Ogunnaike[a] (2002)	Nigeria	To identify and generate items	Focus groups
Patel (1997)	Zimbabwe	To identify and generate items for a measure of mental illness	Focus group Open-ended interviews.
Serpell (1993)	Zambia	To define the construct of Intelligence	In-depth interviews
Sigman (1989)	Kenya	To generate items for a measure of mother--infant interaction	Participant observation
Sternberg (2001)	Kenya	To identify and generate items for a measure of practical intelligence	In-depth interviews with healers

[a]items used were identified in focus group discussion by Aina et al. (1993).

Individual interviews: Serpell (1993) made use of individual in-depth interviews with village elders to examine the conceptualization of intelligence among the Chewa of Zambia. Elders were requested to choose a child who could perform a task at a level that required more than the average skill at his/her age. They were then asked to justify their choices by describing the special characteristics the child possessed. The terms used to describe the child were content analyzed to identify characteristics which the respondents associated with intelligence. This information has been used to describe the Chewa conceptualization of intelligence. Similarly, Mpofu (2001) used written individual interviews with university students and lecturers to find the local definition of intelligence among the Shona in Zimbabwe. To minimize the chances that the participant responses would be influenced by their exposure to Western education and thought patterns, Mpofu requested respondents to exemplify their statements using Shona folktales and proverbs. This work further contributes to the clarification and definition of the construct of intelligence from an African perspective. Ngara and Porath (2004) applied a similar methodology among the Shona to define there concept of giftedness.

Bolton (2001) describes a method where the target population can be involved in evaluating the criterion validity of a measure in the absence of a gold standard. In-depth interviews were administered to key informants in a Rwandese community to identify people suffering from *agahinda gakabii* (a locally described grief syndrome). Criterion validity was evaluated by the level of agreement between the key informants' assessment of the presence of *agahinda gakabii* and the presence of depressive symptoms as described through the Hopkins Symptoms Checklist (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974). Results indicated a pattern of relationship between grief and depression similar to that reported in Western countries. This study suggests that in the absence of a gold standard key informants from the community can provide a means of assessing criterion validity. Bolton, Wilk, and Ndogoni (2004) have applied the same methodology to assess depression in a region that is severely affected by HIV/AIDS in Uganda; the authors confirmed the suitability of the approach provided for assessing criterion validity.

Participant observations: In Kilifi, Kenya we applied participant observation to identify appropriate test stimuli, test administration methods and scoring procedures for developing an adaptation of the Symbolic Play Test (Lowe & Castello, 1976). We observed children aged less than 3 years in both natural and staged environments. Members of the family, especially older siblings were requested to collect and provide the play materials used by the children. Play materials were photographed and catalogued (Taylor & Katana, 2004). This process was carried out until no new materials were observed, after approximately 10 households. Items were selected for inclusion in the play tests and for assessing the materials available in the home in the measure of the home environment based on this catalogue. Children's play behavior (who, how, and

what they play with) was also directly observed and recorded. Overall, approximately 21 households were visited. We began by recording children's play activities in their natural setting. Notes taken focused on the patterns of interactions between the child and the strange visitor as well as between the child and other members of the household. Observations indicated that children were reluctant to engage in play activities in the presence of a strange adult. Subsequent play sessions structured the sessions to help familiarize the child with the stranger. Three stages of child-stranger/assessor interaction were introduced, "modeling", "instructions" and "free play". By incorporating interaction at these three levels of intensity of interaction we were able to observe a reduction in the reluctance of children to participate in play activities with the assessor/stranger.

In Embu (Kenya), Sigman et al. (1988) carried out observations in the home to identify the type of behaviors that could be objectively assessed in a structured observational measure of mother-child interaction. Field workers spent a total of 18 months observing activities in the child's home. This study developed a relatively simple and reliable approach for assessing mother-child interaction, which had high interobserver agreement. The correlation coefficient between observers ranged from .80 to .98 in the six home rearing behaviors observed. This measure has been adopted and successfully applied by other research teams in East Africa (Drotar et al, 1997).

Multimethod Approach

Several of the identified studies have combined more than one consultation method to meet their stated aims. Some studies used triangulation to verify information obtained through one method against another. Other studies sequence their methods so that initial information collected using a single technique is supplemented and fine-tuned by application of other techniques. Ice and Yogo (2005) used a combination of individual interviews and focus group discussions to generate items for a measure of stress among grandparent caregivers of orphans in the Luo community of Kenya. Idioms and items for their measure were generated through individual written interviews with anthropologists from the Luo community. The identified items were used to generate a questionnaire. The investigators then held focus group discussions with grandparent caregivers of HIV orphans. The grandparents were asked to evaluate the questionnaire by explaining what each idiom meant to them. The measure had good psychometric properties.

Grigorenko et al. (2001) collected data in a series of ethnographic studies that involved open-discussions, semi-structured interviews, and group discussions with children and adults. Respondents were asked to identify the most salient qualities of a "good child" and provide vignettes exemplifying these good qualities. This information was used to identify and describe the Luo conceptualization of intelligence. Kambalametore, Hartley, and Lansdown, (2000)

used a multimethod approach involving in-depth interviews, focus group discussions, and participant observation. They examined local concepts of adaptive behavior and identified everyday skills fostered in a Malawian community for inclusion in a measure of psychosocial development. Participants included psychologists, social workers, parents, grandparents, and children in the target age group (aged 4-5 years). As a final example, Alcock and colleagues (in preparation) used a combination of focus group discussions and individual interviews to generate items and examples to be included in a measure of verbal knowledge. During the first step a list of items was generated through a combination of literature review and individual interviews. Focus group discussions were then held with randomly selected groups of people from the community (teachers, parents, adults, and secondary-school pupils) to select item from the generated items. The groups used card-sorting procedure to select items from the list.

What Has Been the Contribution of These Consultations to Test Development?

Construct definition. Participant consultation can reveal salient information about both universal and culture-specific aspects of psychological constructs in a non-Western context. These constructs include intelligence, mental health, and adaptive behavior. The value of the works described in this paper lies in their potential to: "a) reveal limitations in Western psychological constructs; b) add to understanding of psychological theories and constructs; and c) inform culturally sensitive psychological practices in African settings" (Mpofu, 2002, p. 183).

Serpell (1993) presents one of the earliest studies that describe the African concept of intelligence. According to this study, intelligence among the Chewa of Zambia is understood in terms of four indigenous constructs: *nzelu* (wisdom) and *chenjela* (aptitude) which represent the cognitive aspects of intelligence; and *tumilika* (responsibility) and *khulupikila* (trustworthiness) which represent the social aspects. A common finding from studies in Africa is that intelligence has both social and cognitive aspects. Grigorenko et al. (2001) working among the Luo of Kenya reported four facets to the Luo conceptualization of intelligence: *rieko, luoro, winjo*, and *paro*. *Rieko,* which refers to smartness, knowledge, ability, skill, competence and power, is the only aspect that correlated positively with scores from Western ability tests. The others *luoro* (social qualities such as respect and willingness to share), *winjo* (child's ability to comprehend what is going on and understand what is appropriate or inappropriate in a certain circumstance) and *paro* (innovativeness, creativity and the ability to follow through with tasks) did not significantly correlate with academic performance or formal tests. These studies indicate that the African conceptions of intelligence are not limited to cognitive abilities only.

Kambalametore et al. (2000), working in Malawi, report that a well-adapted child is described as one who understands social responsibilities, carries out age-

appropriate chores, and observes social conventions. This is achieved by attaining the quality of *umunthu* (culturedness). Children aged between 4 and 5 years display this quality by participating in household chores such as carrying water and going for small errands, by participating in make-believe play, and by showing an understanding of and respect to relatives. They conclude that, as no Western instrument captures this concept adequately, there is a need to develop a culture-specific instrument to provide a contextually valid measure of child development

Tool development and adaptation: Participant consultation has contributed to different facets of tool development and adaptation, including identification of inappropriate items, generation of substitutes or additional items (Ogunnaike & Houser, 2002; Patel et al., 1997) and the evaluation of the clarity of expression used (Mung'ala-Odera et al., 2004). For instance, only two of the 15 questions in the original format of the Childhood Asthma Questionnaire (French & Christie, 1995) were retained without modification in the adaptation by Holding et al. (in preparation) described earlier. These two, "missed school because of not feeling well" and "Which picture describes how you feel most of the time?" were found to be equally relevant and applicable in the African setting. Other items were found to have unfamiliar prompts such as "watch television" or "go to the swimming pool"; and were replaced with activities that were familiar to the children, such as "chores in the house and on the farm" and "running errands". Preliminary analysis of the schedule indicates good internal consistency of the new scale.

Having developed through participatory consultation what they felt to be a locally valid measure of infant development, the Yoruba Mental Development Scale, Ogunnaike and Houser (2002), compared its performance to that of the Bayley's Mental Infant Development Scales (Bayley, 1993). The Yoruba Mental Development Scale charted age-appropriate maturational changes, with a significant correlation found between age and performance ($r = .44$ $p < .001$). In contrast, the nonadapted Bayley's Mental Infant Development Scales indicated a regression in skill development, with younger children scoring significantly higher than the older children. Furthermore among the Yoruba, intelligence and mental maturity are assessed and encouraged through errand sending. A child is considered to be mature if s/he can take part in household chores and run errands, such as purchasing items and putting away objects. The Yoruba Mental Development Scale significantly correlated with errand running, while Bayley's Mental Infant Development Scales did not have significant correlations with any of the tasks assessed. These results indicate that the locally developed measure of infant development was assessing children's ability more validly in context. In summary, application of information generated through participant consultation has contributed to the development of measures that are reliable and valid for use in SSA.

Discussion

Our review describes the ways in which target populations in studies in sub-Sahara have been included in test construction and adaptation. The inclusion of the community in the process of test development has led to a broader conceptualization of constructs, clearer language reducing ambiguities and the identification of acceptable administration procedures. Participant consultation has been found to enhance construct, content and criterion validity of the measures used while maintaining good internal consistency and test re-test reliability. Researchers have been able to access vocabulary, idioms and appropriate behaviors for inclusion in assessment measures. Moreover, they have identified locally acceptable and theoretically adequate administration procedures for the assessment tasks.

Although admittedly non-exhaustive, our review provides a detailed overview of current practices in consulting target populations in Africa. The most common forms of consultation identified were focus group discussion, in-depth interviews, and participant observation. Previous work in both psychology and anthropology indicates that each of these methods has inherent limitations; therefore, the use of triangulation (i.e., the combination of methods) to collect data might provide the most valuable approach. More work needs to be carried out to improve our understanding of the strengths and weaknesses of various procedures used in consulting target groups, and the applications to which each method can makes its strongest contribution.

Sub-Saharan Africa harbors a remarkable diversity of cultures, although diversity may not preclude the observation of important similarities between cultures. Consulting target populations has proved useful in defining constructs, the most widely studied constructs being intelligence and mental health. In the studies of intelligence in Africa, several commonalities have emerged, such as the inclusion of both cognitive and social aspects to the definition of intelligence. Nevertheless, other psychological constructs may show much more cross-cultural variability, even within sub-Saharan Africa. There is a need to synthesize the information gathered regarding local definitions of constructs in diverse contexts; such a synthesis will enable us build a knowledge base for SSA professionals and it may help to direct future efforts by identifying areas that are still unknown.

Our review indicates the reasons for participant consultation and methods used in SSA are consistent with those observed in other parts of the world where target populations have been involved in item generation, evaluate item wording and stimuli (Haynes et al., 1995; Vogt et al., 2004). This may potentially indicate that the lessons from other regions can be used to inform and further build up this practice in SSA.

While participant consultation brings benefits to the process of test development, several challenges accompany it. For instance, it is often a long and

expensive process; members of the target populations may not talk with the same voice and the suggestions and input may not be feasible or reliable. Other potential limitations include a reliance on an inadequate number of informants, capitalization on culture-specific features of a construct or instrument (at the cost of identifying universal features), and communication problems because crucial words cannot be translated (for example, there are no words for numbers or mood states in some African languages). Researchers need to prepare early on in their research plan on how to deal with these potential challenges.

A limitation of the current review is the relatively few studies identified as having used participant consultation. Several potential explanations exist for this shortage in numbers. Firstly, the small number of studies may be an indication of a low prevalence in systematic consultation with target populations in the region. Secondly, the paucity may be an indication of a publication bias, because few studies publish details on tool development and adaptation procedures. It is fairly common for authors to indicate that tools were piloted without presenting the details. Additionally, there is a chance that most articles detailing tool development have been published in local journals that were not captured through our search. However, our aim was not to carry out an exhaustive systematic search rather we aimed at highlighting the main issues and features relating to participant consultation in SSA.

In summary, we are able to make the following recommendations:

1. Target populations should be consulted at all stages of psychological research to enhance the validity of data collected, its interpretation and evaluation. Consulting target population should be considered a key element of cross-cultural psychology.
2. Special attention should be paid to the sampling procedure. Sampling should take into consideration participant age, educational level, residence (urban/rural), and knowledge of the local culture to ensure the adequacy of the information collected for the whole population under study.
3. Diverse methods of participatory data collection should be used together when using participant consultation. A multimethod approach, in which different consultation methods are combined, such as in-depth interviews and focus groups, can help to increase the validity of measures in communities that are not used to these data collection methods.

It is hoped that our overview will stimulate further discussion and research relating to participant consultation. We believe that close cooperation with target populations is beneficial to both researchers and members of the target population. Researchers gain new insights in universal and culture-specific features of their theories and assessment devices. The needs of target populations may be taken care of if their viewpoints are better represented.

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CHAPTER SEVEN

General Discussion and Conclusions

Developmental and cognitive impairments resulting from exposure to chronic poverty and its co-occurring factors such as malnutrition and infectious diseases are a major problem in many developing countries (Olness, 2003). However, there is a general paucity of data concerning the magnitude of the problem and the degree to which different potential pathways contribute to poor outcome in low-income settings. The problem is exacerbated by a lack of appropriate and standardized measures and procedures for use in these settings. The lack of data on the magnitude of the problem and the absence of appropriate measurement tools hamper the work of child practioneers in providing services aimed at improving child welfare. The current project set out to contribute to knowledge by developing appropriate measures and estimating the effects of three of the leading causes of developmental impairment on child development: poor physical growth, HIV and inadequate parenting behaviour.

In this thesis, the development and evaluation of a measure of psychomotor development for use with children between the ages of 0-3 years in resource-limited settings is presented. Using this instrument the role of infectious diseases, poor physical growth and parenting behaviour in shaping developmental outcome in this population was studied. During these studies a strong effort was made to develop culturally appropriate measurements by including the opinion and views of the communities and parents. Therefore the study also showed how communities and parents can be involved to improve services and research for children in resource-limited settings.

Main findings and conclusion

Development of a culture-informed measure of psychomotor development

The measure of psychomotor functioning that we developed, the Kilifi Developmental Inventory (KDI) and its predecessor the Kilifi Developmental Checklist were found to have excellent psychometric properties (part two of the thesis). The measure is sensitive to neurodevelopmental impairments, nutritional deficiencies and HIV infection. It has a significant correlation with measures of parenting behaviour and quality of stimulation at home. These results present compelling evidence for the validity of the KDI (Kline, 1993). An evaluation of the KDI indicated that it was suitable for use both in clinical and research settings.

The findings of the current project provide evidence that it is both possible and feasible to develop a *culture-appropriate measure* of child outcome in a resource-limited setting in Kenya that has sound psychometric properties. However, developing new measures is time consuming and expensive. Given the fact that the benefits of carrying out valid cross-cultural assessments far outweigh the costs (Van de Vijver, 2002), it is recommended that effort be put in developing and adapting measures for use in sub-Saharan Africa.

Our study indicates that it is feasible to employ *relatively cheap and locally available expertise and technologies* to adequately monitor and enhance the well-being of children in a resource-limited setting. Firstly, we were able to develop a valid measure by using locally available materials, which is relatively cheap. Secondly, we employed staff with limited background in child development; we found that after a brief but systematic workshop and field training they were able to administer the measures adequately.

Anthropometric status, SES and developmental outcome

Part three of the thesis describes two empirical studies, one cross-sectional and one longitudinal. Three indicators of nutritional status, height-for-age (HAZ) weight-for-age (WAZ) and mid-upper arm circumference-for-age (MUAC/A) were found to influence psychomotor functioning and the age of achieving developmental milestones as has been reported earlier (Walker et al., 2007). These studies indicate that the level of SES deprivation itself was not as salient as HAZ, WAZ, and MUAC/A in shaping developmental outcome of children living in poverty. These anthropometric measures played a mediating role in the relationship between indicators of SES and psychomotor outcome. Our path analysis indicates that the SES indicators influence HAZ and WAZ which in turn influence psychomotor function.

The longitudinal data provided complementary insights into the relationship between developmental outcome and SES indicators. Although maternal education, schooling or not, does not have a significant relationship with the initial level of developmental achievement, it does influence the rate at which developmental milestones are achieved. Furthermore, the results of both studies confirm previous findings both in Kenya and elsewhere, which indicate that SES indicators influence children's WAZ and HAZ (Bloss, Wainaina, & Bailey, 2004; Friedman et al., 2005; Frongillo Jr, de Onis, & Hanson, 1997).

The current project has contributed to a greater understanding of the role of *socioeconomic indicators* in developmental psychology in a resource-limited setting. In view of its significant impact on the rate at which developmental milestones are achieved we conclude that maternal schooling is an important contextual factor.

HIV and developmental outcome

Part four of the thesis contains a systematic review of the literature on HIV and child development in Sub-Saharan African (SSA). Even though SSA is home to more than 80% of HIV infected children, little is known of the neurodevelopmental outcomes of HIV infection in this population. Evidence of the effect of HIV infection on neurodevelopmental outcomes for (pre-)schoolchildren aged 3-9 years in Africa comes from two studies (Bagenda et al., 2006; Boivin et al., 1995), involving a total of 38 children, divided in two samples born ten years apart, which can hardly be representative of the HIV infected school-aged population in SSA. In infancy and at toddler age, between 3-24 months, much more research has been done (four studies including an initial 166 HIV positive children). However, also in this population many questions remain unanswered. Certain functional domains such as language functioning have hardly been researched. Based on this review, we concluded that HIV, an ever increasing risk factor for child development in Africa, remains largely *understudied*. Little is known of the interaction of the disease with other co-existing (risk-) factors. Therefore, planning of services, both preventive and remedial, has to depend mainly on research evidence from Western countries, which may very well be culturally inappropriate.

We also concluded that the influence of HIV on motor functioning is unmistakable; however, there is a large amount of variability in outcome and the sources of this variability have yet to be adequately addressed. Our empirical study evaluated the role and contribution of disease stage and weight-for-age in the variability in outcome observed in this population. Results indicate that children at disease stage two and three that reflect progression from primary HIV infection to advanced HIV/AIDS show poor functioning. Regardless of disease stage, children who are underweight performed significantly worse than those who had normal weight. So, an important part of the observed variability in outcome among HIV infected children can be attributed to disease stage and the weight of the child. The *saliency of physical growth* was further emphasized by the fact that its co-existence with HIV will amplify the negative effects of HIV on psychomotor outcome. Given the relative ease and low cost of monitoring physical growth, future efforts should be intensified to use weight to identify at-risk children (de Onis & Habischt, 1996).

Implementing measures to stop vertical transmission of HIV remains the main public health priority. However, for children already infected slowing down disease progression and implementing preventive nutritional care would play a major role in ensuring that they do not suffer avoidable developmental delay in motor functioning.

Assessing parent practices and psychosocial risk

The fifth part of the thesis contains a study with an adapted version of the Home Observation for the Measurement of the Environment(HOME) (Caldwell & Bradley, 2001). In the Kenyan context of the study, the measure had a poor internal consistency; consistent with results from other collectivistic communities, the factor structure of the HOME that has been found in Western countries was not replicated. Despite these poor psychometric results, the total score from the HOME measure had a theoretically meaningful relationship with antecedent factors (SES and maternal education) and with outcome measures (psychomotor development and nutritional indicators). These findings provide evidence for convergent validity (Bradley, Corwyn, & Whiteside-Mansell, 1996).

The study showed that *parenting behaviour* has a significant contribution to developmental outcome in resource-limited settings. However, parenting behaviour, goals and outcomes are culturally defined (Harkness & Super, 2002); therefore, the HOME inventory that is based on Western research can only provide a useful framework for future efforts to develop an appropriate measure for this setting.

The results from the current study indicate that while the correlations between HOME and SES measures are significant they are not strong enough to imply one can replace the other. Both measures should be considered in combination in future studies, because the two are complementary rather than mutually exclusive. To fully understand the psychosocial risk faced by children, it is crucial that we measure both *status variables* (SES indicators) and *process variables* (measures of daily experiences).

Several social-demographic factors have been proposed to identify children who are at risk to suffer from delays in their psychomotor development. Among these factors are gender, age, and rural/urban residence. Our study has not observed gender *influences* on psychomotor functioning, achievement of developmental milestones, nutritional outcomes and parenting. In the current study, being male or female does in itself not constitute a risk. The demographic characteristics with demonstrated adverse effects are *age, maternal lack of schooling* and *rural residence*. Our results indicate that in this community older children are more likely to experience growth faltering (as assessed by higher prevalence rates of deficient weight-for-age and height-for-age). Additionally, results indicate that the rural poor are exposed to much more difficult life circumstances such as poor nutrition and the lack of basic services such as clean water and hygienic toilets compared to the urban poor.

Community participation

In a review of literature, presented in the sixth and last empirical part of the thesis, we describe how psychologists have worked with local communities to enhance the quality of psychological research in Africa. It was concluded that the

use of focus groups, in-depth interviews and participant observation can enhance the construct, criterion and content validity of psychological research in Africa. In an empirical study we observed that mothers from our population provide adequate, valid and reliable information on their children's developmental achievements and that they indicated their willingness to participate in developmental monitoring of their children. Our results indicated that caregivers, the mothers in most cases, were enthusiastic about any programme and activities perceived to improve their children's welfare.

Partnering with communities provides a viable and crucial approach in efforts to improve child well-being. By working with communities we can adequately identify what, where, and how to measure child outcomes. Community members live with the children; the information they provide is most useful in building scientific knowledge; anchoring research in locally relevant settings can help to improve the viability of findings. A firm basis of a study in the local community ensures that the results of research and interventions arising from them are appropriate and acceptable to the target populations.

Theoretical Implications

Two sets of theoretical frameworks guided the work in this thesis; one based in cross-cultural psychology relating to issues and approaches to developing appropriate assessment procedures for resource-limited settings and the second one from developmental psychology, the bio-ecological model. The theoretical implications of the work described in the thesis for the two frameworks are discussed in the following sections.

Assessment: A detailed taxonomy of sources of bias as presented by Van de Vijver and Tanzer (2004) guided the work in this study. Our results indicate that the focus of the taxonomy during tool development will largely depend on the construct assessed. Psychomotor development generally has a more universal pattern of development compared to any other domain of child functioning; Western conceptualizations of psychomotor development can be used in Kenya. What still needs adaptation, are the methods of administering the measure and contents of items that are not familiar to the child (method and item bias). Compared to psychomotor development, parenting practices are much more defined and influenced by cultural factors (Bornstein & Cote, 2004). As a consequence, other forms of bias have to be addressed, notably construct bias. Our results indicate that construct bias may not be easily addressed through adaptation and may be best addressed by assembling a whole new measure. Our project demonstrates that there is no panacea for cultural adaptations. However based on our findings and experiences from the field we highlight a four-stage approach that can be used to adapt or assemble psychological tools for use in most resource-limited settings. Table 1 below presents each of the stages

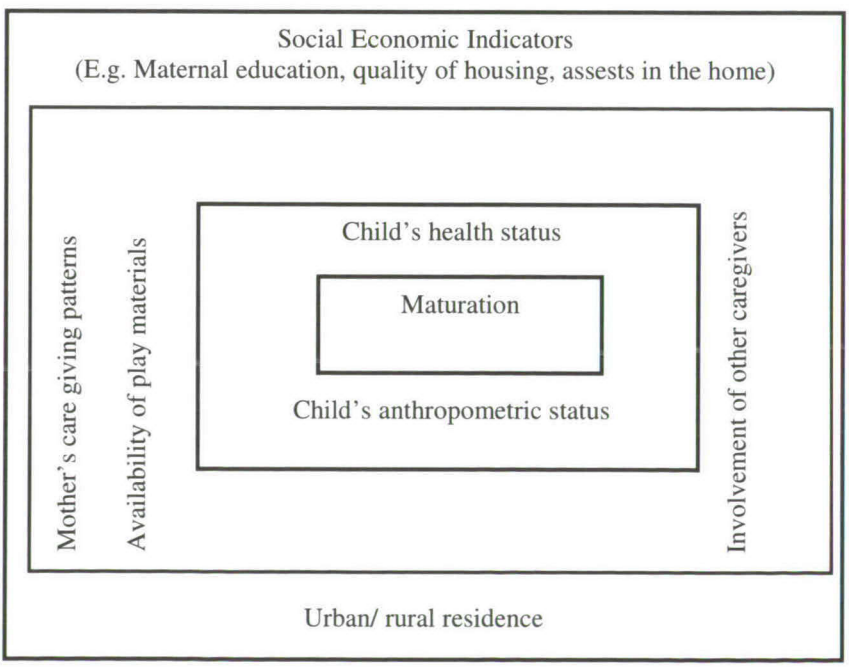
highlighting some of the issues to be addressed and methods that can be used at each stage.

Table 1. *Four-Stage Approach to Tool Development for Use in a Resource-Limited Setting*

Construct definition		
Sub stage	Issues to address	Method to use
Systematic review of existing literature.	▪ Definition of construct ▪ Review existing tools ▪ Check if the existing tools been used in a different cultural context.	○ Literature review
Consult experts in the field familiar with the community	▪ Item translation ▪ Definition of construct in the local community ▪ Evaluate the level of appropriateness of the items	○ Individual interviews (both oral and written) ○ Focus group discussion ○ Item rating
Consult target groups	▪ Definition of the construct in the local community ▪ Face validity of the item/ tasks ▪ Cultural appropriateness of the items/tasks	○ Focus group discussion ○ Individual interviews ○ Participant observations.
Item pool creation		
List the items in a questionnaire format.	▪ Integrate in formation from the input of all stakeholders listed above	
Test development		
Item selection	▪ Relevance to the community ▪ Relevance to the construct ▪ Method of administration ▪ Clarity of instructions. ▪ Clarity of language being used. ▪ Familiarity of test materials ▪ Suitability to the testing environment.	○ Panel approach ○ Statistical methods
Development of accompanying test material.	▪ Training manuals for the assessment team. ▪ Coding and administration manuals ▪ Setting of minimal levels of competence for each assessor.	
Test evaluation		
Investigating psychometric properties	▪ Reliability and validity in a reference population. ▪ Sensitivity in a risk group.	○ Appropriate statistical approaches
Community evaluation	▪ Acceptability ▪ Willingness to take part ▪ Aspect of the new measure that may need re-evaluation	○ Focus groups ○ Individual interviews

Developmental psychology: Our study results generally confirmed the usefulness of bio-ecological models in studying health-related issues in children from poor backgrounds (Trawick-Smith, 2003). However, the ecological model integrates many layers and many aspects of the environment (Bronfenbrenner, 1979). It is very rare to find a study where all the potential layers of the ecology are studied. This is especially true in a setting like the one we work in due to a shortage of resources. We therefore present a preliminary simplified conceptual and analytical model for future studies of psychomotor development of children under the age of three; especially those applying the Kilifi Developmental Inventory. Figure one below presents a summary of this conceptual framework. In the figure we present four levels. The inner most level, labelled 'maturation' reflects the impact of genetic and neurobiological processes. This level has the strongest impact on psychomotor performance, while the outer level labelled 'SES indicators and area of residence' has the least influence.

Figure 1. *A tentative simplified analytical and conceptual model for studying factors impacting on psychomotor development of infant-toddlers within Kenya.*



Furthermore, within the Kenyan context, the factors that contribute to *optimal child development* are similar to those identified elsewhere. This similarity suggests that intervention measures used in other regions of the world might be useful in Kenya after systematic adaptation, implementation, and

evaluation. Our study indicates that some of the factors contributing to optimal child development are

- Maternal schooling.
- Availability of sufficient material resources, such as sanitary facilities, clean water and basic food stuffs as evidenced by their influence on anthropometric outcomes.
- Optimal physical growth.
- Maternal active involvement in structuring child's activities
- Availability of age-appropriate play materials.
- An appropriate level of involvement of others in the household in stimulating the child. These include fathers and siblings.
- Involvement of mothers in developmental monitoring by asking them to report developmental achievements of their children as part of the routine postnatal care.

Practical Implications

Our study has resulted in a relatively cheap and culture-appropriate measure that can be used in Kenya, and potentially other resource-limited settings to identify and monitor at-risk children. Based on the results from the cross-sectional and longitudinal studies, we would recommend a two–tier system for following up children. The children would first be screened and those identified as potentially at-risk would be referred for more detailed assessment (Carter, Briggs-Gowan, & Davis, 2004). In our case the Developmental Monitoring Form employing parental report would be used in this stage. The children identified as being potentially at-risk can then be referred for more detailed performance-based assessments using the Kilifi Developmental Inventory. This approach would maximize the viable use of the few resources available in sub-Saharan Africa.

Based on our focus group discussion with mothers we illustrate that there is a need to raise parental awareness of developmental milestones. In the effort to provide more integrated child health care programmes such a programme could be provided as part of the Antenatal Services where mothers are usually taught about nutrition and feeding patterns but where child development is never on the agenda. Parental knowledge of child's developmental achievements is important in many ways including assisting the parent to actively engage in identifying at-risk children, and encouraging the parent to stimulate their children's development (Bornstein & Cote, 2004).

Our results indicate that as children grow older (toddler hood to 36 months) they may be more at risk; indeed many already show developmental delay. Yet there are currently no services in Kenya aimed at monitoring the health and well-being of this age group. Infants get monitored through the mother child health programme in health facilities. The early child programmes in Kenya target children who have started attending nursery schools (Kindergartens, usually at the

age of 3 or 4 years). There is a need to have programmes specifically targeted at the toddler years.

Critical Review of the Current Project

Our project has several important strengths; these include the fact that we have used locally developed and validated measures. The approach taken in developing the measures ensures that the description of the effects of exposure to risk is made at a more detailed and accurate level. Furthermore, our study has combined longitudinal and cross-sectional design in addressing research questions.

However, the current project has a three-fold limitation. Firstly, the study provides an in-depth analysis of assessment issues, risk factors and methodological issues relating to infancy and toddler hood. Unfortunately, the study only reports on psychomotor development; other functional areas such as language and socio-emotional development are not addressed, due to logistical and time constraints. Developing and evaluating a measure in each of these areas requires a lot of effort and resources beyond a single project. Therefore future efforts will focus on assessing other functional areas at the same level of details. Secondly, we have carried out an in-depth analysis of how biological and environmental factors influence developmental outcomes. However we did not measure the child's contribution to this outcome. Aspects such as the child's temperament and behavioural regulation were not included in the analysis; yet there is sufficient evidence that shows that each child brings it's own unique contribution to the environment; children are not just influenced by the environment they live in but also influence it themselves and hence create their own context and experiences (Sameroff & Chandler, 1975; Sameroff, 2000). Therefore, future studies should attempt to include the contribution of child's personal characteristics in the study. Third, our study had a longitudinal component; however, the advantages of the longitudinal approach were not fully realized. Our follow-up period was brief, and we had a limited sample size. Future efforts should attempt to replicate our findings with larger samples and to follow children up to preschool age to fully document the influences on child development over time.

Recommendations for Future Research

Based on the findings from the current project the following broad recommendations can be made regarding future research. There is a need for intensive and long running longitudinal studies within sub-Saharan Africa to better understand developmental trajectories and their antecedents. One aspect not addressed in our study is how the trajectory changes as the risk factors changes. For instance how the development of a child who is stunted would be influenced when the child's height-for –age catches up? Would there be an improvement in

performance too or would it be difficult or even impossible to catch up? And what are the factors that would moderate such a relationship?

Considering the role of quality of care the child receives in shaping developmental outcome (Richter, 1999; Walker et al., 2007), there is an urgent need to build on the work we have carried out so far and to develop a culturally-appropriate and valid measure of the home environment for use in resource-limited settings such as our study environment in Kenya. Such a measure would be useful in identifying children in need of intervention resulting from exposure to sub-optimal home environment. Moreover, researchers can use the measure to document how biomedical and psychosocial risk factors interact to shape developmental outcomes.

Given that developing countries are home to an estimated 85% of people with disabilities, most research in this region tends to focus on factors that contribute to poor outcome. However, there is also a need to study foundations of competence in risky environments. Such studies fundamentally seek to investigate: why so many children who grow up in deprived conditions develop into healthy adults. The identified contributing factors can be integrated into intervention programmes. These would then greatly enhance the efficacy of intervention programmes (Masten & Coatsworth, 1998).

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SUMMARY

Developmental and cognitive impairments resulting from exposure to chronic poverty and its co-occurring factors such as malnutrition and infectious disease are a major problem in many developing countries. However, there is a general paucity of data on the magnitude of the problem and the degree to which the different potential pathways contribute to poor outcome in resource-limited settings. The problem is exacerbated by a lack of appropriate and standardized measures and procedures for use in these settings. The lack of data on the magnitude of the problem and the absence of appropriate measurement tools hamper the work of child practitioners in providing services aimed at improving child welfare. The current project set out to deepen our insight in developmental and cognitive impairments by developing appropriate measures and estimating the effects of three of the leading causes of developmental impairments in developing countries: poor physical growth, HIV and inadequate parenting behaviour.

Chapter 1 presents conceptual and theoretical issues that guided the design of the study and interpretation of our findings. In the conceptualization of this study we paid specific attention to the fact that the first three years of life are very important to optimal brain development. Brain development and the differentiation of functions are influenced by both genetic and environmental factors. An important environmental factor is poverty, which is known to negatively influence childhood outcome. Poverty occurs in situations of multiple risks, there are therefore potentially many pathways by which poverty exerts its influence on childhood outcome. The bio-ecological theory provides the main theoretical background for this work. According to this theory, human development is a result of an interaction between the person and the environment. A detailed taxonomy of sources of bias as presented by Van de Vijver and Tanzer (2004) guided the work in this study in terms of adapting and developing assessment measures. According to this taxonomy there are three potential sources of bias in cross-cultural assessment. These are construct, method and item bias. To address this bias one may need to adapt or assembly a whole new measure. The current study used both approaches in tool development.

The aim of *Chapter 2* was to develop a culturally appropriate measure of psychomotor development for use in resource-limited settings. Two empirical studies were presented. In the first empirical study reported in this chapter we developed a measure of developmental outcome for children aged 1-9 years. The initial impetus for this development was provided by the need to monitor the effects of prophylaxis for seizures following cerebral malaria on developmental outcomes. This measure labelled the Kilifi Developmental Checklist (KDC) was found to be valid and reliable. However, there was a need to further enhance KDC's sensitivity and focus the measure to assessing children under the age of three. Based on this refinement the Kilifi Developmental Inventory (KDI) was

developed. The KDI focuses on assessing psychomotor development. In a population to 319 rural children and 104 urban children the KDI was found to be both reliable and valid. Furthermore, the measure was sensitive to neurodevelopmental disorders, nutritional deficiencies and HIV infection. Mothers who participated in the study reported that they found the measure acceptable and assessment procedures to be informative. It was concluded that it is possible to develop a culture informed measures that is valid for use in sub-Saharan Africa.

The aim of *Chapter 3* was to document the influence of anthropometry on psychomotor development. We presented data on the relationship between SES, anthropometry and childhood outcomes in two empirical studies. In the first study a cross-sectional design was used to study the relationship between the three variables in a group of 204 children aged 24-35 months. We observed that anthropometry fully mediated the relationship between SES and psychomotor development in this population. Head circumference for age did not show the same intervening role although it had a strong influence on psychomotor outcome. These results indicated that head growth may be the anthropometric measure least susceptible to environmental influences. In a longitudinal study of children aged 2-10 months at the initial point of recruitment the role of anthropometry was further emphasized as we found that poor physical growth especially stunting was able to predict both the initial developmental status and rate of achieving new developmental milestones. Weight-for-age was predictive of the initial developmental status while maternal education and ill-health predicted the rate at which new skills were achieved. The results indicated that interventions targeting nutritional outcomes are likely to positively influence psychomotor outcomes in this population.

The aim of *Chapter 4* was to document the effects of HIV infection on child development in Sub-Saharan Africa (SSA). The first study was a systematic review of the neurodevelopmental effects of HIV on the paediatric population in SSA. The review indicated that there is sufficient evidence that HIV negatively influences child development in sub-Saharan Africa. Major knowledge gaps were also identified. The knowledge gaps include the lack of sufficient studies on certain developmental domains such as language, few studies of children above the age of 2 and a lack of studies addressing the potential source of variability in outcome in the HIV populations. The second study, which was empirical, aimed at addressing the absence of information on sources of variability in the HIV population in SSA. We investigated and found that part of the variability in outcome of HIV infected children can be explained by disease stage and weight-for age. We observed a drop in scores in each successive disease stage (based on 1990 WHO clinical definition and staging of HIV) with children at disease stage three showing the worst outcome. However our results indicated that weight-for-age had a more salient role in shaping the poor psychomotor outcomes in this

population compared to disease stage. In fact our results indicated that weight-for-age may be a salient pathway by which disease stage exerts its influence on psychomotor development. In this chapter two sets of recommendations are made. First, there is need for more studies investigating the influence of HIV on children in sub-Saharan Africa. Second, interventions aimed at improving nutritional status will contribute to slowing down the negative influence of HIV on psychomotor outcomes.

Chapter 5 was aimed at evaluating the role of parenting behaviour and stimulation at home on childhood outcome. An adapted version of the Home Observation for the Measurement of the Environment (HOME) was employed in this study. Despite extensive adaptations the measure showed poor psychometric qualities (i. e., low alpha values). Furthermore, we could not replicate that factor structure of the published measure in this population. Still, we found that the total score of the HOME correlated with outcome measures (psychomotor development and height-for-age) and antecedent factors (maternal education and social-economic status). Our results show that parenting behaviours do influence childhood outcomes in our populations. A more detailed explanation of this explanation can only be achieved by developing a valid measure of parenting behaviour and stimulation provided at home. While the correlations between the SES measures and HOME scores were significant, they were not strong enough to suggest that one can statistically account for the other. This indicates that one can not be used in the place of the other. Instead they should be used as complementary measures to be able to fully describe the psychosocial risk faced by children in resource poor settings.

Chapter 6 was aimed at evaluating the role of local communities and target populations in ensuring enhanced validity of research findings and services to the paediatric population in SSA. In a review of articles we found that using quantitative approaches such as Focus groups discussions, individual interviews and participant observation; Researchers in SSA have been able to enhance the construct, content and criterion validity of their work. In an empirical study with mothers in the community we found that they were enthusiastic about participating in developmental monitoring because they found the procedures both informative and beneficial. Moreover, the information they provided about the achievement of developmental milestones by the children was both valid and sensitive to developmental risk factors. It is concluded that partnering with communities is a feasible and viable approach to ensuring improved research and services for children in sub-Saharan Africa.

In *Chapter 7* I drew conclusions and discussed the results presented in the thesis in this chapter. It is concluded that infectious diseases, anthropometric status and parenting are salient pathways by which poverty exerts its influence on developmental outcomes among children in resource-limited settings. In our study I confirmed that the bio-ecological framework provides a useful approach to

studying influences to child development in resource poor setting. Based on our findings I present a simplified analytical and theoretical model for studying psychomotor development of children aged 0-36 months in resource poor settings in Kenya and potentially other developing countries. This model has four levels or layers with the inner most layers having the highest and direct impact on outcome. The levels are (from proximal to distal): (1) normal maturation changes as measured by chronological age (2) child health and nutritional status; (3) parenting behaviour and stimulation at home; (4) the social-economic status and area of residence (i. e., rural/urban).

Regarding tool development the results indicated that there is no simple answer to what should be done. The choice on whether to adapt an existing measure or develop a whole new measure should be based on the construct being measured. When assessing constructs with demonstrated universality adapting existing measures may provide the best approach, while when dealing with constructs that are more culturally determined constructing a whole new measure may be the best option. Regardless of whether one decides to adapt or develop an instrument I present a four-staged approach that can be used to obtain culturally appropriate measures of developmental outcome for resource poor setting. The four stages of our tool adaptation model are: construct definition, item pool creation, material preparation and instrument evaluation.

Future efforts should focus on carrying out more intense longitudinal studies to allow for a more detailed understanding of the developmental trajectories of the children in this environment and be able to describe the moderators and mediators to the developmental trajectories. This knowledge would allow for adequately planning of intervention programmes aimed at improving the welfare of children in SSA.

SAMENVATTING

Achterstand in groei of cognitieve ontwikkeling als gevolg van chronische armoede en daarmee gepaard gaande verschijnselen zoals ondervoeding en besmettelijke ziekten, vormen een groot probleem in veel ontwikkelingslanden. Desondanks is er weinig bekend over de omvang van het probleem en over de vraag welke mechanismen bijdragen aan de ontwikkelingsachterstand van kinderen in arme omgevingen. Het probleem wordt nog vergroot door een gebrek aan goede en gestandaardiseerde maten en procedures die in dergelijke omstandigheden gebruikt kunnen worden. Het werk van hulpverleners die proberen het welzijn van het kind te bevorderen is hierdoor bemoeilijkt. Dit promotieproject probeert meer inzicht te geven in de achterstand in cognitieve ontwikkeling en lichamelijke groei door goede tests samen te stellen en te evalueren. Daarnaast wordt de invloed van drie belangrijke oorzaken van ontwikkelingsachterstand bij kinderen in ontwikkelingslanden zo goed mogelijk in kaart gebracht: slechte fysieke groei, HIV-infectie en inadequate opvoeding door de ouders.

Hoofdstuk 1 beschrijft conceptuele en theoretische aspecten die ten grondslag gelegen hebben aan het ontwerp van de huidige studie en de interpretatie van de resultaten. Bij de conceptualisering van de studie hebben we vooral aandacht besteed aan het feit dat voor een optimale ontwikkeling van het brein de eerste drie levensjaren van groot belang zijn. De hersenontwikkeling en differentiatie van functies worden door genetische factoren en omgevingsfactoren beïnvloed. Een belangrijke omgevingsvariabele is armoede; hiervan is bekend dat dit een negatieve voorspeller is van de ontwikkeling van een kind. Armoede komt altijd voor in een omgeving waarin ook allerlei andere risicofactoren zijn; daarom kan armoede op allerlei manieren van invloed zijn op de ontwikkeling van het kind. De bio-ecologische theorie van Bronfenbrenner vormt de theoretische achtergrond van deze studie. Deze theorie stelt dat de ontwikkeling van de mens een gevolg is van de interactie van een persoon en de omgeving.

Een gedetailleerde taxonomie over vormen van vertekening die beschreven is door van de Vijver en Tanzer (2004) ligt ten grondslag aan de ontwikkeling van nieuwe instrumenten en het aanpassen van bestaande instrumenten in dit project. In deze taxonomie zijn er drie mogelijke bronnen van vertekening in crossculturele diagnostiek. Deze zijn construct-, methode- en itemvertekening. Om adequaat vertekening tegen te gaan kan het nodig zijn om een bestaand instrument aan te passen of een nieuw instrument te ontwikkelen.

Het doel van de studie die beschreven wordt in *hoofdstuk 2,* was om een instrument te maken dat psychomotorische ontwikkeling kan meten op een wijze die recht doet aan de culturele achtergrond van de kinderen en dat gebruikt kan worden in een omgeving met beperkte middelen ofwel veel armoede. Twee empirische studies worden besproken. In de eerste empirische studie in dit

hoofdstuk werd een maat samengesteld om het ontwikkelingsniveau bij kinderen van 1 tot 9 jaar vast te stellen. Het instrument is eigenlijk gemaakt vanuit de behoefte om de effecten van profylactische middelen tegen toevallen bij hersenmalaria op de ontwikkeling van het kind te meten. De test, de Kilifi Developmental Checklist (KDC) genaamd, bleek valide en betrouwbaar te zijn. Toch bleek het nodig om de gevoeligheid van de test te verbeteren en om in het instrument meer nadruk te leggen op het onderzoek bij kinderen jonger dan drie jaar. Op basis van deze verfijningen is de Kilifi Developmental Inventory (KDI) samengesteld. De KDI heeft vooral tot doel om de psychomotorische ontwikkeling te bepalen. De test bleek zowel betrouwbaar als valide te zijn in een onderzoekgroep van 319 kinderen van het platteland en 104 kinderen uit de stad. Verder was de test gevoelig voor neurologische ontwikkelingsstoornissen, voedseldeficiënties en HIV-infectie.
De moeders die deelnamen aan het onderzoek gaven aan dat ze geen moeite hadden met de inhoud en vorm van de test en dat de testprocedures informatief waren. De conclusie van het onderzoek was, dat het mogelijk is om een instument te creëeren dat recht doet aan de lokale cultuur en dat goed bruikbaar is in "Sub-Saharan Africa" (SSA, de gebruikelijke Engelstalige aanduiding voor het deel van Afrika dat ten zuiden van de Sahara ligt).

Hoofdstuk 3 had tot doel om de invloed van lichamelijke groei op de psychomotorische ontwikkeling te beschrijven. In twee empirische studies beschreven we data over de relatie tussen socio-economische status, antropometrie en de ontwikkeling van kinderen. De eerste studie gebruikte een cross-sectioneel design om de relatie tussen deze drie variabelen te bestuderen in een groep van 204 kinderen van 24 tot 35 maand. We vonden dat in deze populatie de antropometrische gegevens de relatie tussen socio-economische status en psychomotorische ontwikkeling volledig medieerde. Hoofdomtrek (passend bij de leeftijd van het kind) speelde niet dezelfde mediërende rol, hoewel deze variabele een sterke invloed op psychomotorische ontwikkeling liet zien. Deze resultaten gaven aan dat de hoofdomtrek de antropometrische maat is die het minst onder invloed van de omgeving staat. In een longitudinaal onderzoek onder kinderen van 2 tot 10 maanden bleek een belangrijke rol voor antropometrie; we vonden namelijk dat een slechte fysieke groei (in het bijzonder "stunting" wanneer het kind ernstig achterblijft in groei ten opzichte van de leeftijd) een goede voorspelling gaf van het psychomotore functioneren van het kind bij de eerste meting en ook van de snelheid van de ontwikkeling over de duur van het onderzoek. Gewicht voor de leeftijd van het kind was een voorspeller van de psychomotore ontwikkeling bij de eerste meting; de scholing van de moeder en de gezondheid waren een voorspeller van de snelheid van de ontwikkeling tijdens de duur van het onderzoek. De resultaten gaven aan dat interventies die gericht zijn op voeding en fysieke groei waarschijnlijk een positieve invloed hebben op de psychomotorische ontwikkeling in deze populatie.

In *hoofdstuk 4* werd de invloed van HIV-infectie op de ontwikkeling van het kind in SSA nagegaan. De eerste studie was een systematisch literatuuroverzicht van neurologische ontwikkelingseffecten van HIV in een pediatrische populatie in SSA. Uit het overzicht bleek dat er voldoende evidentie is om te concluderen dat HIV een negatieve invloed heeft op de ontwikkeling van kinderen in SSA. Er zitten echter ook nog flinke hiaten in onze kennis. Deze betreffen het gebrek aan studies op een aantal specifieke ontwikkelingsdomeinen, zoals taal, het gebrek aan studies van 2-jarige kinderen en een gebrek aan studies waarom HIV bij sommige kinderen veel meer invloed heeft op de ontwikkeling dan bij andere. De tweede studie was empirisch van aard en had betrekking op de variabiliteit in de invloed van HIV in SSA. Ons onderzoek toonde aan dat een deel van de variabiliteit verklaard kan worden door de progressie van de ziekte (ziektefase) en gewicht voor de leeftijd van het kind. We vonden dat scores op de tests afnamen met het toenemen van de ziektefase (gebaseerd op de WHO klinische definitie van fasen van HIV uit 1990); kinderen in de derde ziektefase vertoonden de laagste testscores. Onze resultaten gaven echter aan dat gewicht in relatie tot de leeftijd een belangrijkere voorspeller van de slechte psychomotorische scores was dan ziektefase. De invloed van ziektefase op psychomotorische ontwikkeling zou via het gewicht kunnen verlopen. Er werden twee soorten aanbevelingen gedaan in dit hoofdstuk. Op de eerste plaats is er behoefte aan meer studies naar de invloed van HIV op de ontwikkeling van kinderen in SSA. Op de tweede plaats zullen interventies waarin getracht wordt de voedselstatus van kinderen te verbeteren kunnen leiden tot een afname van de negatieve invloed van HIV op de ontwikkeling van kinderen.

Hoofdstuk 5 had tot doel om de rol van het opvoedingsgedrag van ouders en stimulatie thuis op de ontwikkeling van het kind te evalueren. In deze studie werd een geadapteerde versie van de Home Observation for the Measurement of the Environment (HOME) gebruikt. Ondanks talrijke adaptaties had het instrument slechte psychometrische eigenschappen (d. w. z. lage alfa-waarden). Verder bleek het onmogelijk in deze populatie de factorstructuur te repliceren die in de literatuur gerapporteerd is. Toch vonden we dat de totaalscore van de HOME gecorreleerd was met metingen van het ontwikkelingsniveau (psychomotorische ontwikkeling, gewicht en lengte voor de leeftijd) en antecedente factoren (scholing van de moeder en socio-economische status). Onze resultaten toonden aan dat opvoedingsgedrag van de ouders van invloed is op de ontwikkeling van het kind in onze populaties. Een betere verklaring van deze invloed is enkel mogelijk door een nieuwe maat voor opvoedingsgedrag en stimulatie thuis te ontwikkelen. De conclusie van het onderzoek was dat hoewel de HOME een nuttig raamwerk biedt, het instrument allerlei aanpassingen behoeft om een cultureel adequate meting van opvoedingsgedrag en stimulatie thuis te worden. Hoewel de correlaties tussen de socio-economische statusmaten en de scores op de HOME significant waren, waren deze niet sterk genoeg om

aannemelijk te maken dat de maten statistisch inwisselbaar zijn. Dit betekent dat de ene maat niet voor de andere gebruikt kan worden, maar dat beide als complementaire maten gebruikt moeten worden, als men een volledige beschrijving van de psychosociale risicofactoren wil maken waar kinderen in arme omgevingen mee te maken krijgen.

Hoofdstuk 6 had tot doel om na te gaan in hoeverre lokale gemeenschappen en doelgroepen onderzoeksbevindingen en diensten aan de pediatrische populatie in SSA kunnen versterken. In een literatuuroverzicht vonden we dat onderzoekers in SSA in staat gebleken zijn de construct-, inhouds- en criteriumvaliditeit van hun werk te vergroten door middel van kwalitatieve technieken zoals discussies in focusgroepen, individuele interviews en observatie van deelnemers. In een empirische studie onder moeders uit de gemeenschap vonden we dat ze enthousiast waren over hun deelname aan onderzoek waarin de ontwikkeling van hun kind precies bijgehouden werd. Ze vonden de procedures zowel informatief als behulpzaam. Verder vonden we dat de informatie die ze gaven over de leeftijd waarop kinderen bepaalde dingen kunnen doen, valide was en ook gevoelig was voor de aanwezigheid van risicofactoren in de ontwikkeling van het kind. Geconcludeerd werd dat het opnemen van de moeders als partners in het onderzoek een goede en bruikbare methode is om onderzoek en diensten aan kinderen in SSA te verbeteren.

In *Hoofdstuk 7* werden conclusies getrokken en de resultaten van de hoofdstukken van dit proefschrift besproken. Geconcludeerd werd dat infectieziekten, antropometrische status en opvoedingsgedrag belangrijke wegen zijn waarlangs armoede invloed heeft op de ontwikkeling van kinderen die opgroeien in een omgeving met beperkte middelen. In onze studie vonden we een bevestiging dat het bio-ecologische raamwerk een nuttige benadering is om de ontwikkeling van kinderen in armoede te bestuderen. Op basis van onze bevindingen stellen we een vereenvoudigd analytisch en theoretisch model voor om psychomotorische ontwikkeling van kinderen tussen 0 en 36 maand te bestuderen die opgroeien in armoede in Kenia en mogelijk ook in andere ontwikkelingslanden. Dit model heeft vier lagen waarbij de binnenste laag de sterkste en meest directe invloed op ontwikkeling heeft. De lagen zijn (van proximaal naar distaal): (1) normale veranderingen als gevolg van rijping zoals gemeten op basis van de kalenderleeftijd; (2) gezondheid en groei van het kind en voedselstatus; (3) opvoedingsgedrag en stimulatie thuis; (4) de socio-economische status en woonplaats (platteland of stad).

Op het terrein van instrumentontwikkeling toonde onze studie aan dat er geen eenvoudig antwoord is op de vraag wat gedaan moet worden. De keuze of een bestaande test geadapteerd moet worden of dat een heel nieuwe maat ontwikkeld moet worden, hangt af van het construct dat gemeten wordt. Als er een construct gemeten wordt waarvoor sterke evidentie bestaat dat het universeel is, zou adaptatie van bestaande maten de best mogelijke benadering kunnen zijn;

als men echter te maken heeft met constructen die een sterkere culturele definitie hebben, kan het maken van een heel nieuw instrument de beste optie zijn. Ongeacht of besloten wordt een bestaande test aan te passen of een heel nieuwe test te ontwikkelen stellen we een benadering voor instrumentontwikkeling voor die uit vier stappen bestaat. Een toepassing van deze benadering zorgt ervoor dat een maat samengesteld wordt die cultureel gezien adequaat is om de ontwikkeling van kinderen te meten die in armoede opgroeien. De vier fases van ons model om een instrument te ontwikkelen zijn: constructdefinitie, maken van een set items, vervaardigen van het materiaal en instrumentevaluatie. In ons model geven we aan wat er in elke fase gedaan moet worden en welke methoden gebruikt kunnen worden om problemen op te lossen.

Op basis van onze bevindingen stellen we een benadering in twee stappen voor om interventies te doen bij kinderen die in omgevingen wonen met veel armoede. Toekomstig onderzoek zou zich meer moeten richten op longitudinale studies zodat we een beter inzicht krijgen in het ontwikkelingsverloop van de kinderen in deze omgeving en de modererende en mediërende variabelen in hun ontwikkeling te kunnen beschrijven. Hierdoor wordt het mogelijk om betere interventieprogramma's op te zetten die gericht zijn op het welzijn van kinderen in SSA.

APPENDIX 1: KILIFI DEVELOPMENTAL CHECKLIST

Compiled in September 1996

KEMRI No.	[___][___][___][___][___][___]
Name	[_____][_____]
Sex M/F	[___]
Date of Birth	[___][___]/[___][___]/[___][___]
Checked on clinic card Y/N	[___]
Date of assessment (1)	[___][___]/[___][___]/[___][___]
Age (months) at assessment (1)	[___][___]
Date of assessment (2)	[___][___]/[___][___]/[___][___]
Age (months) at assessment (2)	[___][___]
Name of observer/facilitator	[_____][_____]
Code for observer/facilitator	[___] [___]

Other information: (Health of child – who accompanied the child)

Checked
Entry 1:
Entry 2:

TASK				Ass 1	Ass 2
COIN BOX					
picks up coin, any method **R L**	picks up coin between thumb and finger **R L**	can put coin in the box **R L**	can put coin in rotated box: shakily **R L**	can put coin in rotated box: easily **R L**	puts in 6 coins in rotated box **R L**
If ALL 6 coin times are 20 secs + STOP					
R6	Trial 1.....(secs) Trial 2.....(secs)				
R12	Trial 1.....(secs) Trial 2.....(secs)				
L6	Trial 1.....(secs) Trial 2.....(secs)				
L12	Trial 1.....(secs) Trial 2.....(secs)				
EHCB	Score *(count number of boxes ticked)*				
EH1	Can pick up coins anyway (1) with thumb and forefinger always (2)				

BLOCK TOWER				
can retain cube in either hand when given		retains one cube when second offered	picks cube up from table or floor	mature (radial) grasp
can hold 2 cubes in one hand		retains 2 cubes when third offered	Releases 1 cube on top of another.	builds tower 3-4 cubes
builds tower 5-6 cubes		builds tower 7-8 cubes	builds tower 9-10 cubes	builds tower 11-12 cubes
EHNC	Total number of cubes			
EHBT	Score (*count number of boxes ticked*)			
EH2	Can build small tower block 2 blocks (1) 4+ blocks (2)			
EH3	Can build tower block 5 blocks (1) 8+ blocks (2)			
VISION: RING AND BEADS				
EH4	Grabs at dangling ring reaches for (1) takes ring (2)			
EH5	Can hold and examine object *(ring, bear etc.)* examination observed (1) passes from hand to hand (2)			
EH6	Can touch coloured beads at least 2 (1) 5+ (2)			
EH7	Can touch transparent beads at least 2 (1) 5+ (2)			
EH8	Can pick up and put beads into pot at least 2 (1) 5+ (2)			
	TASK		**Ass 1**	**Ass 2**
HEARING				
HSL1	Reacts to spoken word / sounds does not respond at all (0) observer has some concern (1) observer has no concern (2)			
COPYING SHAPES				
EH9	Maze puzzle 1			
EH10	Maze puzzle 2			
EH11	Maze puzzle 3			
EH12	Copies circles			
EH13	Copies shapes			

BUTTON			
EH14	Can do up button with adult holding one piece (1) alone (2)		
LYING AND STANDING			
LM1	Stands with support (1) with no support(2)		
LM2	Can sit down unsteadily with support (1) steadily/ without support (2)		
LM3	Sits with support (1) can reach out and return to sitting position (2)		
LM4	Moves from lying to sitting (with arms straight out) push up with hands (1) not using hands (2)		
LM5	Moves from sitting to standing rolling over and up (1) not using hands (2)		
PLAYING WITH THE BALL			
EHC	Number of **CATCHES** (out of first 5)		
EH15	Catches a ball using arm and hands (1) hands only (2)		
EH16	**THROWS** ball releases ball (1) towards somebody (2)		
EHK	Number of **KICKS** (out of first 5 leg swings)		
LM6	Kicks a ball Child ball not moving (1) Kick a moving object (2)		

	TASK	Ass 1	Ass 2
MOVING			
LM7	**WALKS** when held with one hand (1) walks without help (2)		
LM8	**RUNS** sometimes falling (1) for length of room (2) (Definition of running: requires change in body angle and knee bending)		
LMJ	Number of consecutive **jumps** (max. 30)		
LM9	Jumps with two feet together holding on to persons hand (1) alone, both feet leave the ground (2)		
LMS	Time for **STANDING ON ONE LEG** (max. 3 mins)		
LM10	Stands on one leg, with support or alone for 3 seconds (1) for at least 10 seconds (2)		
LMW	Number of steps on **TIP TOE** max. 2 lengths of room)		
LM11	Walk on Tip Toes for 3 or more steps (1)		

	for length of room (2) (heels must have clearly left the ground)		
LM12	Climbs the chair (to take ball) – see HSL9 can pull self onto chair (1) can climb straight on to feet (2)		
LM13	Jumps off chair with support (1) lands on both feet (2)		
LMSK	Number of **SKIPS** (max. 4 circles)		
LM14	Skips slowly/always leading with the same foot (1) alternate feet, flowing (2)		
LMH	Number of **HOPS** (max. 2 lengths of room)		
LM15	Hops on one leg less than length of room (1) length of room (2)		
LMWB	Number of **STEPS BACKWARDS** (max. 2 lengths of room)		
LM16	Walks backwards with support or for less than length of room (1) alone for length of room (2)		
LM17	Walks along line heel to toe, arms out Number of correct steps		

TASK				Ass 1
CONTAINERS AND CUBES				
Rattles box	Lifts lid box (not knocking off/0ver)	Tries to take cube out of box	Manages to take 1 cube out of box	Removes both cubes from box
Opens 2 boxes	Puts 1 cube in box (encourage)	Puts 2 cubes in box (encourage)	Puts cubes in and out of box	Puts lids back, trial and error
Puts 2 cubes and lid back		Puts lid back, adjusts lid to box	Puts 3 boxes together	Assembles boxes by colour
EHBC	Score (*count number of boxes ticked*)			
EH17	Removes object from container reaches in (1) complete success (2)			
PICTURE BOARD				
EH18	Returns pieces 1-4 trial and error (1) compiled correctly (2)			
HSL2	Comprehension Total score			

SOCIAL AND EMOTIONAL DEVELOPMENT						
behaviour	1	2	3	4	5	6
State of (1) conciousness	Unrousable	drowsy	Sleepy but easily awake	Awake uninterested	loses interest	Maintains interest
Emotional (2) state	irritable, inconsolable	irritable, consolable (mother)	irritable when approached	shy or neutral	happy, smiling	
Social (3) orientation	avoiding, withdrawn	hesitant	accepts approach (just)	friendly		
SE1	State of consciousness *(score)*					
SE2	Emotional state *(score)*					

SE3	Social orientation *(score)*	

HEARING SPEECH AND LANGUAGE		
COMPREHENSION; in response to instructions		
HSL3	Responds to own name never (0) sometimes (1) always when not busy (2)	
HSL4	Responds to simple instructions e. g. give me the cup – lift your arms – sit down never (0) when accompanied by gestures (1) follows verbal instructions (2)	
HSL5	Responds to a series of verbal instructions e. g. climb on the chair and fetch the ball never (0) when accompanied by gestures (1) follows verbal instructions (2)	

EXPRESSIVE LANGUAGE: in response to questions			
HSL6	Early vocalization present (1) absent, only uses proper words (2) absent, no sounds except crying (0)		
HSL7	Single words/ 2 words/ words and gestures no words heard (0) all utterances at this level or lower (1) utterances at this level, perhaps some higher (2)		
HSL8	Single sentences no sentences heard (0) all utterances at this level or lower (1) utterances at this level, perhaps some higher (2)		
HSL9	A series of sentences in a conversational form no connected sentences heard (0) one example at this level (1) more than 1 example at this level (2)		

PARENT INTERVIEW			
		Ass 1	Ass 2
EATING/FEEDING Kwanza nambira kuhusu maryadzige -Maryadzige gakaladze kahiza mwezi uno udzokira? -anarya kila kitu hedu ni kukahala kurya? -ukimulola unaona anarya zha kuthosheka? -nikukala unahendadze kuhusu kurya kwakwe, je unaona ni shida?			
SE4	Eats normally, does not make a mess or be encouraged to eat occasional problems (1-2 p. w) (1) always (2)		
INDEPENDENCE / SELF CARE -kuvala nguo mwenye -kuoga mwenye -kunwa kinywaji			
SE5	Can dress him/herself with some help with fastenings only (1) alone (2)		

SE6	Can wash him/herself with supervision (1) alone (2)		
SE7	Can drink from cup some spillage (1) alone (2)		
SOCIAL COMPETENCY Adze yuno muhoho akirichwa hakeye? -anahenza mutu amuimirire? -je anadima kuhumwa kwenda tengeza utu hakeye dza vivi e g. kwenda heka madzi, kwenda dukani, kwenda zaziga?			
SE8	Can be sent on errands with escort of another child (1) alone (2)		
A. WETTING B. SOILING Kuhusiana na kwenda haja, yuno X nikudzikodzolera hedu kudzinyerera bila kumanya na mtsana? -ni kudzinyerera dza maranyingahi? -je, kudzikodzolera? -je, usiku?			
SE9	Dry during the day 1 /2 accidents p. w (1) always (2)		
SE10	Clean during the day (soiling) 1 /2 accidents p. w (1) always (2)		
SE11	Is clean and dry during the night 1 /2 accidents p. w (1) always (2)		

SOCIAL RELATIONSHIPS (SIBLINGS AND PEERS) Uhusiano wa X na nduguze wakaladze uno mwezi udzokira? -je, X ni kuzaziga tototo na nduguze hedu ni kukala na wivu, ama kunenezana au kukosana? -kuna ahoho angine hehi ario anadima kuzaziga nao? -ahoho a miaka mingahi? -akikala hamwenga nao manazazigadze?			
SE12	Social relationships Does not seek company (0) Seeks company, but can have problems arguing or sharing (1) An extremely sociable child (2)		
LEVEL OF CONCERN Mwisho kuhusu tabiaze kwa jumula undaambadze? Kakuhenda ukakala na wasiwasi?			
SE13	Health often sick (0) sometimes sick (1) healthy (2)		
SE14	Language concerned, not making any progress (0) concerned, but making some progress (1) making progress (2)		
SE15	Others (specify) very concerned, would like advice (0) some concern, will wait and see (1) happy (2)		

APPENDIX 2 : Kilifi Developmental Inventory

STUDY NUMBER: [_I_][_T _][_S _][__][__][__]
CHILD'S NAME: [_____ _____] [__][__]
TIME ARRIVED AT HOME: [_____]
ASSESSMENT DATE: [__][__]/[__][__]/[__][__]
AGE AT ASSESSMENT: [____] **Months** [____] **Days**
ASSESSOR INITIALS: [____][____]
OBSERVER INITIALS: [____][____]
Test session observations

Health		
Mood		
a) Crying/ inconsolable	**b)** Occasional crying	
c) Changeable (mood swings)	**d)** No visible emotions	
e) Occasional smiles	**f)** Smiling/laughing	[____]
Child's activity level		
a) Unarousable	**b)** Sleepy can hardly be awaken	
c) Sleepy but easily awake	**d)** Does not spontaneously engage in activity	
e) Awake but loses interest	**f)** Active and maintains interest	[____]
Child's interaction with the assessor		
a) Avoidant and withdrawn	**b)** Clings to family member	
c) Hesitant (when approached will accept reluctantly)	**d)** Difficult to engage in tasks	
e) Inappropriate approaches to assessor	**f)** Friendly	[____]
Any unusual events during testing		

Weight: [__ _._]**kgs**
Height: [____.___]**cms**
Head circumference: [____.___]**cms**
Mid-upper arm circumference: [____. ___]**cms**

Instruction:
Brief the person accompanying the child on the tasks and the role they are expected to play during the assessment.

START TIME [____:____]

MOVING		**Yes/No**
LM 01	Stands with support	
LM 02	Stands without support	

PLAYING WITH THE BALL		
Code/score		**Yes/No**
EH 01	**THROWS** and **CATCHES** ball Highest string achieved (3 games)	
EH 02	**Releases a ball** purposefully	
EH 03	Throws a ball towards someone	
EH 04	**Catches** a ball using arms and hands	
EH 05	Catches a ball using hands only	
LM 03	**Can kick** a ball from stationary position	
LM 04	Can kick a moving ball	

MOVING		
Code/score		**Yes/No**
LM 05	**Walks** when held with one hand	
LM 06	Walks without help	
LM 07	**Jumps** with two feet together, holding on to person's hand	
LM 08	Jumps with two feet together unsupported both feet leave the ground	
LM 09	**Stands on one leg**, without support for 10 – 20 seconds	
LM 10	Stands on one leg, without support for 21 seconds+	
LM 11	**Walk on tip toes** for 3 or more steps	
LM 12	Walk on tip toes for length of mat	
LM 13	**Walks backwards** with support or for less than length of mat	
LM 14	Walks backwards alone for length of mat	
LM 15	**Walks along line** heel to toe, arms out for 3 steps	
LM 16	Walks along line heel to toe, arms out for length of mat	
LM 17	Walks on side of feet	
LM 18	Can **pull** self onto platform	
LM 19	Can climb straight onto platform	
LM 20	**Jumps off** platform with support	
LM 21	Jumps off platform and lands on both feet	
LM 22	**Hops on one** leg on spot	
LM 23	Hops on one leg for length of mat	

Code/score		***Yes/No***
LYING AND STANDING		
LM 24	Lifts upper body while lying on stomach	
LM 25	Sits with support	
LM 26	Can sit steadily/ without support	
LM 27	No head lag in sitting position	
LM 28	Can reach out and return to sitting position	
LM 29	**Rolls** from side to back	
LM 30	Rolls from side to side	
LM 31	**Moves from lying** to sitting pushing up with hands	
LM 32	Moves from lying to sitting not using hands	
LM 33	**Moves from sitting** to standing rolling over and up	
LM 34	Moves from sitting to standing not using hands	
LM 35	Can sit down steadily (from a standing position)	

Code/score		**Yes/No**
VISION: RING AND RED TASSEL		
EH 06	Reaches for dangling ring	
EH 07	Takes dangling ring	
EH 08	Follows red tassel with eyes/attempts to grasp	
EH 09	Grasps red tassel successfully	
EH 10	Can hold and examine object (ring, bear etc)	
EH 11	Passes object from hand to hand	
BUTTON		
EH 12	Can do up button with adult holding one piece of cloth	
EH 13	Can do up button alone	

BLOCK TOWER			
A. Can retain cube in either hand when given	**B**. Retains one cube When second offered	**C**. Picks cube up from mat	**D**. Mature (radial) Grasp
E. Can hold 2 cubes in one hand	**F**. Retains 2 cubes when third offered	**G**. Releases one cube on top of another	**H**. Builds tower 3-4 cubes
I. Builds tower 5-6	**J**. Builds tower 7-8 cubes	**K**. Builds tower 9-10 cubes	**L**. Builds tower 11-

cubes			12 cubes
EH 14	Number of boxes ticked		

CONTAINERS AND CUBES				
A. Rattles box	**B**. Lifts lid of box (not knocking off/over)	**C**. Tries to take cube out of box	**D**. Manages to take 1 cube out of box	**E**. Removes both cubes from box
F. Opens 2 boxes	**G**. Puts 1 cube in box (encourage)	**H**. Puts 2 cubes in box (encourage)	**I**. Puts cubes in and out of box	**J**. Puts lids back, trial and error
K. Puts 2 cubes and lid back	**L**. Puts lid back, adjusts lid to box	**M**. Puts 3 boxes together	**N**. Assembles boxes by colour	
EH 15	Score (count number of boxes ticked)			

COIN BOX					
A. Picks up coin any method R L	**B**. Picks up coin between thumb and finger R L	**C**. Can put coin in the box (slot horizontal) R L	**D**. Can put coin in rotated box (slot vertical) shakily R L	**E**. Can put coin in rotated box: easily R L	**F**. Puts in 6 coins in rotated box R L
EH 16	Score (count number of ticks)				
EH 17 R 6 Rotated box	**a**) Trial 1(secs)				
	b) Trial 2(secs)				
	c) Trial 3(secs)				
EH 18 L 6 Rotated box	**a**) Trial 1(secs)				
	b) Trial 2(secs)				
	c) Trial 3(secs)				

BEAD THREADING		**Yes/NO**
EH 19	Picks up beads with pincer grasp	
EH 20	Drops beads into container	
EH 21	Threads 2 beads onto shoe lace	
EH 22	How many in 30 secs. **a**) Trial 1	
	b) Trial 2	
	c) Trial 3	

PAPER AND PEN		
Score		**Yes/NO**
EH 23	Holds a pen in any way	
EH 24	Holds a pen between finger and thumb	
EH 25	Can scribble using a pen	
EH 26	Can imitate a straight line	
EH 27	Can imitate a circle	

TIME [____:____]

APPENDIX 3: Developmental Milestones Form

Study number: [ ] [ ]/ [ ] [ ]/ [ ] [ ]
Date of birth: [ ][ ] / [ ][ ] / [ ] [ ] [ ] [ ]
Date of visit: [ ][ ] /[ ] [ ] /[ ] [ ]
Child's age: [ ] months [ ]days
Weight: [ ] in Kgs
Height: [ ] cms
Head circumference: [ ] cms
Mid- upper arm circumference: [ ] cms

Health concerns

1) Ask if the child has been ill in the last one month Yes [ ] No [ ]

2) If they were ill, what was the problem?

3) How severe was the problem

4) What actions did the mother take? (Did the mother take the child to hospital or not? Was there a need for hospitalisation?)

5) Are there any concerns regarding the child's growth and development?

Coding information

2. Has been able to carry out the activity in the last one month
1. Starting to learn the activity
0. Not yet started
99. Parent/ caregiver cannot tell / recall/ has not observed.

	DEVELOPMENTAL MILESTONES	
	LOCOMOTOR	
	Head control	
DLM 01	Holds head erect for a few minutes	
DLM 02	Controls the head	
	Sitting	
DLM 03	Sits supported	
DLM 04	Sits alone on the floor	
	Crawling	
DLM 05	Crawls	
	Standing	
DLM 06	Stands when held up	
DLM 07	Pulls self while holding on to object into a standing position	

DLM 08	Stands holding on to furniture or object	
DLM 09	Stands alone	
	Walking	
DLM10	Walks when held	
DLM11	Walks alone	
	Climbing	
DLM 12	Climbs onto a low chair	
DLM 13	Climbs out of a low chair	
	Others	
DLM 14	Runs	
DLM 15	Jumps	
DLM 16	Kicks football	
DLM 17	Throws football	
	FINE MOTOR	
	Watching and reaching	
DFM 01	Watches a moving item in front of face	
DFM 02	Reaches out for objects unsuccessfully	
DFM 03	Reaches out and grasps objects	
	Picking	
DFM 04	Picks up small objects in anyway	
DFM 05	Picks up small objects using one hand rather than two	
DFM 06	Picks grains	
	Writing	
DFM07	Holds a pen in anyway	
DFM08	Holds a pen between finger and thumb	
DFM09	Scribbles with a pen	
	Opening	
DFM10	Opens a door that requires pushing.	
DFM11	Opens a door by turning and pulling doorknob.	
	LANGUAGE	
	Pre-speech	
DL 01	Repeats vowels in strings e. g. aa aa aa	
DL 02	Repeats syllables in strings e. g. ma ma ma	
DL 03	Uses synonyms e. g. tamu tamu for sweet foods	
DL 04	Uses onomatopes. These are words that describe sounds in a particular situation. E. g. mee for goat, boo for cow	
DL 05	Uses gestures to communicate	
	Words	
DL 06	Uses one definite word	
DL 07	Says more than three words	
DL 08	Says more than ----- words (record the number of word the mother says)	
DL 09	Uses two words combinations	
	Naming and identification	
DL 10	Identifies familiar objects: record the number reported	
DL 11	Names familiar objects: record the number reported	
	PERSONAL –SOCIAL	
	Reaction to others	
DPS 01	Regards person: fleeting	
DPS 02	Maintains eye contact	
DPS 03	Smiles	
DPS 04	Vocalizes when talked to	
	Recognition of others	
DPS 05	Visually recognises the mother	
DPS 06	Knows strangers from familiar people	

DPS 07	Reaches out for familiar people	
DPS 08	Goes happily with people he know	
	Self recognition	
DPS 09	Reacts to own name	
	Play	
DPS 10	Watches others and plays next to them.	
DPS 11	Shows an interest in what others are doing.	
DPS 12	Joins other children in play	
	Dressing	
DPS 13	Tries to help dress arms into a shirt or blouse.	
DPS 14	Undresses self	
DPS 15	Dresses self with minimal assistance	
DPS 16	Dresses self without any assistance.	
	Feeding	
DPS 17	Takes liquids from cups when held to lips	
DPS 18	Drinks from a cup with assistance	
DPS 19	Can manage a cup well.	
DPS 20	Uses hands to feed self: spillage	
DPS 21	Uses hands to feed self: no spillage	
DPS 22	Uses spoon to feed self: spillage	
DPS 23	Uses spoon to feed self: no spillage	
	Soiling	
DPS 24	Usually stays dry and clean for up to an hour	
DPS 25	Indicates when wet	
DPS 26	Usually says when pressed (wants to go for a short call).	
DPS 27	Bowel control complete, rarely dirty by day	

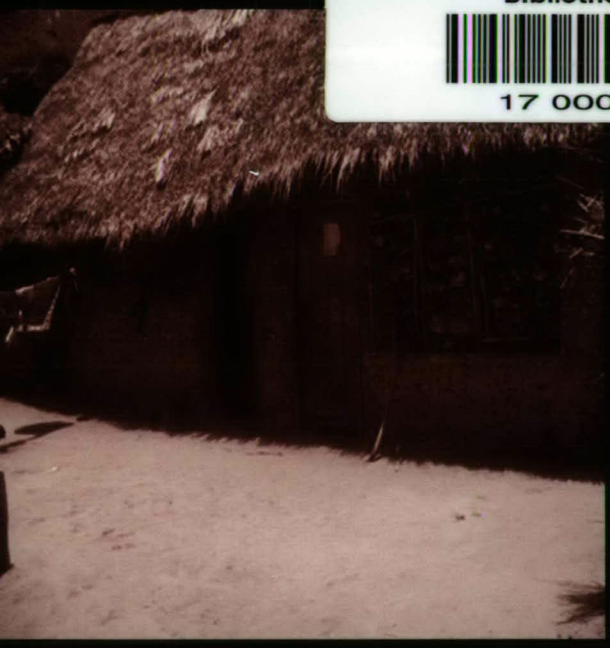
Appendix 4 *Items of the Kenyan Infant-Toddler Version of the Home Observation Measure of the Environment, Modal Responses per Age Category, and Correlations with Outcome and Socioeconomic Status Variables*

	Modal response (percentage choosing this response)			Correlation with outcome and SES variables			
Items	<12	12-24	24-35	motor	Meduc	Age	SES
1. Parent allows child to engage in " messy play"	2 (86%)	2 100%)	2 (93%)	n/a	n/a	n/a	n/a
2. Parent spontaneously vocalizes to child at least twice	1 (79%)	1 (79%)	2 (75%)	.06	.10*	02	.17*
3. Parent spontaneously vocalizes to child's vocalizations	2 (71%)	2 (74%)	2 (69%)	.04	.14**	-01	.19**
4 Parent tells child name of object or person during visit	1 (67%)	1 (70%)	1 (65%)	.18**	.18**	.16**	.17**
5. Parents speech is distinct, clear and audible	2 (100%)	2 (99%)	2 (96%)	n/a	n/a	n/a	n/a
6. Parent initiates verbal interchange with visit	2 (99%)	2 (94%)	2 (100%)	n/a	n/a	n/a	n/a
7. Parent converses freely and easily.	2 (100%)	2 (99%)	2 (100%)	n/a	n/a	n/a	n/a
8. Parent spontaneously praises child at least twice	0 (59%)	0 (69%)	0 (71%)	.02	.01	-.04	-.07
9. Parent voice conveys positive feelings towards child	2 (96%)	2 (99%)	2 (90%)	n/a	n/a	n/a	n/a
10. Parent caresses or kisses child at least twice	2 (61%)	2 (42%)	0 (63%)	-.44**	-.06	-.48**	-.05
11. Parent responds positively to praise of child offered by visitor	1 (91%)	1 (90%)	1 (88%)	n/a	n/a	n/a	n/a
12. No more than one instance of physical punishment during the past week	2 (82%)	2 (57%)	2 (54%)	-.13**	-.08	.15**	-.17*
13. Family has a pet	1 (67%)	1 (62%)	1 (55%)	.06	-.17	-.10*	.35*
14. Parent does not shout at child during visit	2 (100%)	2 (99%)	2 (99%)	n/a	n/a	n/a	n/a
15. Parent does not express overt annoyance or hostility to child	2 (100%)	2 (99%)	2 (99%)	n/a	n/a	n/a	n/a
16. Parent spanks or slaps during visit	2 (99%)	2 (99%)	2 (99%)	n/a	n/a	n/a	n/a
17. Parent does not scold or criticize child during visit	2 (99%)	2 (97%)	2 (97%)	n/a	n/a	n/a	n/a

18. Parent does not restrict child more than three times during visit	2 (100%)	2 (99%)	2 (100%)	n/a	n/a	n/a	n/a
19. At least ten books are present and visible	0 (74%)	0 (83%)	0 (77%)	.02	.29**	.04	.16*
20. child's care if used, is provided by one of 3 regular substitutes	2 (96%)	2 (86%)	2 (95%)	n/a	n/a	n/a	n/a
21. Child is taken to grocery store at least once a week	2 (47%)	2 (52%)	2 (72%)	.22**	.13*	.23**	.29**
22. Child gets out of house at least 2 times a week	2 (62%)	2 (75%)	2 (82%)	.19**	-.03	.15*	.14
23. Child is taken regularly to doctor's office or clinic	2 (85%)	2 (87%)	0 (74%)	-.51**	-.06	-.58**	-.12
24. Child has access to toys and treasures	2 (76%)	1 (60%)	1 (85%)	-.23**	.00	-..24**	.17*
25. Child's play environment is safe	2 (97%)	2 (92%)	2 (100%)	n/a	n/a	n/a	n/a
26. Muscle activity toys and equipment	1 (51%)	1 (70%)	1 (74%)	.13*	-.11*	-.11	-.24**
27. Push or pull toys	0 (61%)	1 (66%)	1 (70%)	.27**	.03	.16**	-.16*
28. Stroller or walker or kiddies car, scooter or tricycles	0 (47%)	1 (58%)	1 (52%)	-.03	.01	-.02	-.07
29. Cuddly toys or roll playing toys	0 (82%)	1 (47%)	1 (51%)	.53**	.13*	.47**	.08
30. Learning facilitators	0 (100%)	0 (99%)	0 (96%)	n/a	n/a	n/a	n/a
31. Simple eye-hand coordination toys	0 (99%)	0 (58%)	1 (80%)	.63**	.07	.62**	-.21**
32 Complex eye-hand coordination toys	0 (100%)	0 (90%)	0 (63%)	.38**	.00	.41**	-.21**
33 Toys for literature and music	0 (73%)	0 (75%)	0 (65%)	.12*	.15**	.11*	.22**
34 Parent provides toys for child to play with during visit	1 (62%)	1 (59%)	0 (55%)	.11*	-.02	-.19**	.08
35 Parent talks to child while doing household	0 (62%)	2 (50%)	2 (79%)	.43**	.09	.43**	-.11
36. Parent consciously encourages developmental advance	2 (80%)	2 (83%)	2 (79%)	-.02	-.16**	-.06	.22**
37. Parents invests in maturing toys with value via personal attention	0 (85%)	0 (75%)	0 (82%)	-.03	-.11*	-.04	.33**

38. Parent structures child's play periods	1 (48%)	1 (60%)	1 (69%)	-.15*	-.03	-.15**	-.04
39. Parent provides toys that challenges child to develop new skills	0 (90%)	0 (87%)	0 (87%)	-.02	-.11	-.02	.09
40. Parent keeps child in visual range	1 (53%)	1 (53%)	2 (54%)	n/a	n/a	n/a	n/a
41. Father provides some care daily	1 (83%)	1 (88%)	1 (83%)	.12*	.03	.14**	.04
42. Parent reads or tells stories to child	0 (97%)	0 (99%)	0 (92%)	n/a	n/a	n/a	n/a
43. child eats at least one meal a day with mother and father	0 (76%)	0 (84%)	0 (58%)	.18**	.19**	.21**	.42**
44. family visits relative or receives visits once a month or so	1 (76%)	1 (71%)	1 (74%)	.05	.04	.02	-.01
45. Child has his/her own books	0 (99%)	0 (100%)	0 (98%)	n/a	n/a	n/a	n/a

Meduc- Maternal Education, SES –Social Economic Status, N – Not applicable because the items had limited variability. *$p < .05$. **$p < .01$.



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